NORTHROP

WL-TR-91-3104

FINITE ELEMENT ANALYSIS OF ASTOVL FIGHTER STRUCTURE

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December 1991

Interim Report for period 1 October 1988 - 1 October 1989

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UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED	1b. RESTRICTIVE MARKINGS
2a. SECURITY CLASSIFICATION AUTHORITY	3. DISTRIBUTION/AVAILABILITY OF REPORT Approved for Public Release; Distribution is Unlimited.
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE	
4. PERFORMING ORGANIZATION REPORT NUMBER(S) NOR 89-101	5. MONITORING ORGANIZATION REPORT NUMBER(S) WL-TR-91-3104
6a. NAME OF PERFORMING ORGANIZATION NORTHROP CORPORATION AIRCRAFT DIVISION 6b. OFFICE SYMBOL (If applicable) 3855/82	7a. NAME OF MONITORING ORGANIZATION Flight Dynamics Directorate (WL/FIBAC) Wright Laboratory
6c. ADDRESS (City, State, and ZIP Code) One Northrop Avenue Hawthorne, California 90250	7b. ADDRESS (City, State, and ZIP Code) Wright-Patterson AFB, Ohio 45433-6553
8a. NAME OF FUNDING/SPONSORING ORGANIZATION 8b. OFFICE SYMBOL (If applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER Contract No. F33615-88-C-3205
8c. ADDRESS (City, State, and ZIP Code)	10. SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO. 63211F; PROJECT NO. 69CW; TASK NO. 01; WORK UNIT ACCESSION NO. 88

11. TITLE (Include Security Classification)

FINITE ELEMENT ANALYSIS OF AN ASTOVL FIGHTER STRUCTURE

12. PERSONAL AUTHOR(S)
J. A. Hangen

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (Year, Month, Day)	15. PAGE COUNT
Interim	FROM 10/1/88 TO 10/1/89	December 1991	257

16. SUPPLEMENTARY NOTATION

17. COSATI CODES		
FIELD	GROUP	SUB-GROUP

18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
FINITE ELEMENT MODEL, ULTRALIGHTWEIGHT STRUCTURES, ASTOVL, DESIGN OPTIMIZATION

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

This report documents the static/dynamic and aeroelastic finite element model development and description used for the preliminary structural design and optimization of an Advanced Short Takeoff and Vertical Landing (ASTOVL) fighter structure. The model defined represents an Automated STructural Optimization System (ASTROS) compatible model initially developed from a NASTRAN finite element model. The generated data are for the purpose of enabling the repeat of the structural analysis and to independently analyze the structure in case of future structural or operational modifications to the aircraft.

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT ☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT ☐ DTIC USERS	21. ABSTRACT SECURITY CLASSIFICATION UNCLASSIFIED
22a. NAME OF RESPONSIBLE INDIVIDUAL Mr. Keith Bowman	22b. TELEPHONE (Include Area Code) (513) 255-6639 22c. OFFICE SYMBOL WL/FIBAC

DD FORM 1473, 84 MAR

83 APR edition may be used until exhausted
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UNCLASSIFIED

FOREWORD

This report presents the finite element analysis of the Advanced Short Takeoff and Vertical Landing (ASTOVL) fighter structure. It was prepared by the Northrop Corporation, Aircraft Division under Contract F33615-88-C-3205, entitled "Ultralightweight Structures." This report is in full compliance with Contract Data Requirements List (CDRL) Number 1. This contract is administered under the technical direction of Dr. Edvins Demuts (WL/FIBAC), Flight Dynamics Directorate, Wright-Patterson Air Force Base, Dayton, Ohio. The analytical work in this report was conducted from 1 October 1988 to 1 October 1989 by Mr. J. A. Hangen III. The assistance of Mr D. J. Neil is acknowledged during this effort including debugging and enhancing of the ASTROS computer code. The generated data are for the purpose of enabling the repeat of the structural analysis and to independently analyze the structure in case of future structural or operational modifications to the aircraft.

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LIST OF ABBREVIATIONS, SYMBOLS, AND ACRONYMS

ACSYNT	Northrop version of NASA's Aircraft Synthesis computer program
ASTOVL	Advanced Short Takeoff and Vertical Landing
ASTROS	Automated Structural Optimization System
BC	Boundary Conditions
BHD	Bulkhead
CADAM	2-D Computer Augmented Design and Manufacturing graphical software
GDR	Generalized Dynamic Reduction - algorithm to efficiently calculate frequencies and modes shapes
FASTOP	FASTOP3, Strength, Deflection, and Flutter Structural Optimzation Computer System
HATOL	Horizontal Attitude Takeoff and Landing
MLG	Main Landing Gear
NASTRAN	NASA Structual Analysis computer program
NCAD	Northrop 3-D Computer Aided Design
NCASA	Northrop Computer Aided Structural Analysis - NASTRAN pre- and post-processor
NCV	NORLOADS to ASTROS Aerodynamic Model Converter
NLG	Nose Landing Gear
NORLOADS	Northrop Maneuver Loads Analysis computer program
RALS	Remote Augmented Lift System
REVWING	Northrop Rapid Evaluation of Wing computer program
USSAERO	Woodwards unified subsonic and supersonic aerodynamic panel computer program
V/STOL	Vertical or Short Takeoff and Landing
1-D	One-Dimensional
2-D	Two-Dimensional

ABBREVIATED LIST OF NASTRAN/ASTROS COMMANDS, KEYWORDS, ROUTINES

KEY WORD	TYPE	DESCRIPTION
ATTACH	bulk data	connection of aerodynamic panels to a single structural GRID
AUTOSPC	parameter	to request automatic removal of stiffness singularites from the stiffness matrix (NASTRAN only)
CBAR, BAR	bulk data	bending bar element connection
CONM2	bulk data	concentrated mass element
CQDMEM1, QDMEM1	bulk data	quadrilateral membrane element connection
CQUAD4, QUAD4	bulk data	quadrilateral membrane-bending element connection
CROD, ROD	bulk data	rod element connection
CONROD,	bulk data	rod element connection
CTRIA3, TRIA3	bulk data	triangular membrane-bending element connection
CTRMEM, TRMEM	bulk data	triangular membrane element connection
DCONSTR	bulk data	stress/strain design constraint
DCONTHK	bulk data	thickness design constraint
DESELM	bulk data	design variable properties for a single finite element
DESVARS	bulk data	design variable properties for shape function linked elements
DESVARP	bulk data	design variable properties for physically linked elements
GRID	bulk data	geometric location of grid point of the structural model

ABBREVIATED LIST OF NASTRAN/ASTROS COMMANDS, KEYWORDS, ROUTINES (Continued)

KEY WORD	TYPE	DESCRIPTION
MPC	bulk data	multiple point constraint - rigid connection of GRIDs
NDV	variable	number of global design variables
NRFAC	solution control	number of retained constraints = NRFAC * NDV
PCOMP	bulk data	plate and shell element properties defined as a composite layed-up ply by ply
PLIST	bulk data	defines property entries associated with a design variable
SAERO	solution control	schedule static aeroelastic discipline
SHAPE	bulk data	define elements associated with a design variable and assign linking factor
SPLINE1	bulk data	area spline for connection/load transformation from aerodynamic model to structure model
SPLINE2	bulk data	linear or beam spline for connection/load transformation from aerodynamic model to structure model
STATICS	solution control	schedule Static analysis discipline
SUPORT	bulk data	define GRID and direction in which to apply determinate reactions on a free body
ZANLYN	routine	complex coupled eigenvalue flutter solver (ASTROS)

SECTION 1

INTRODUCTION

Short takeoff and/or vertical landing capabilities for future fighter aircraft are becoming increasingly important to meet the demands of landing on damaged or improvised runways, to operate from remote and austere sites in challenging environments, and to perform multiple sorties effectively. To achieve ASTOVL capabilities, fully optimized structural concepts are required utilizing advanced materials and innovative manufacturing technologies. Preliminary design of an ASTOVL fighter is needed to assess the potential impact of these advanced materials, manufacturing technologies, structural optimization methods, and preliminary design concepts on an ASTOVL vehicle's performance and mission capabilities.

This report documents the static/dynamic and aeroelastic finite element model development and description used for preliminary structural design and optimization of the N382-20 ASTOVL fighter. The model defined herein represents an ASTROS compatible model initially developed from a NASTRAN finite element model.

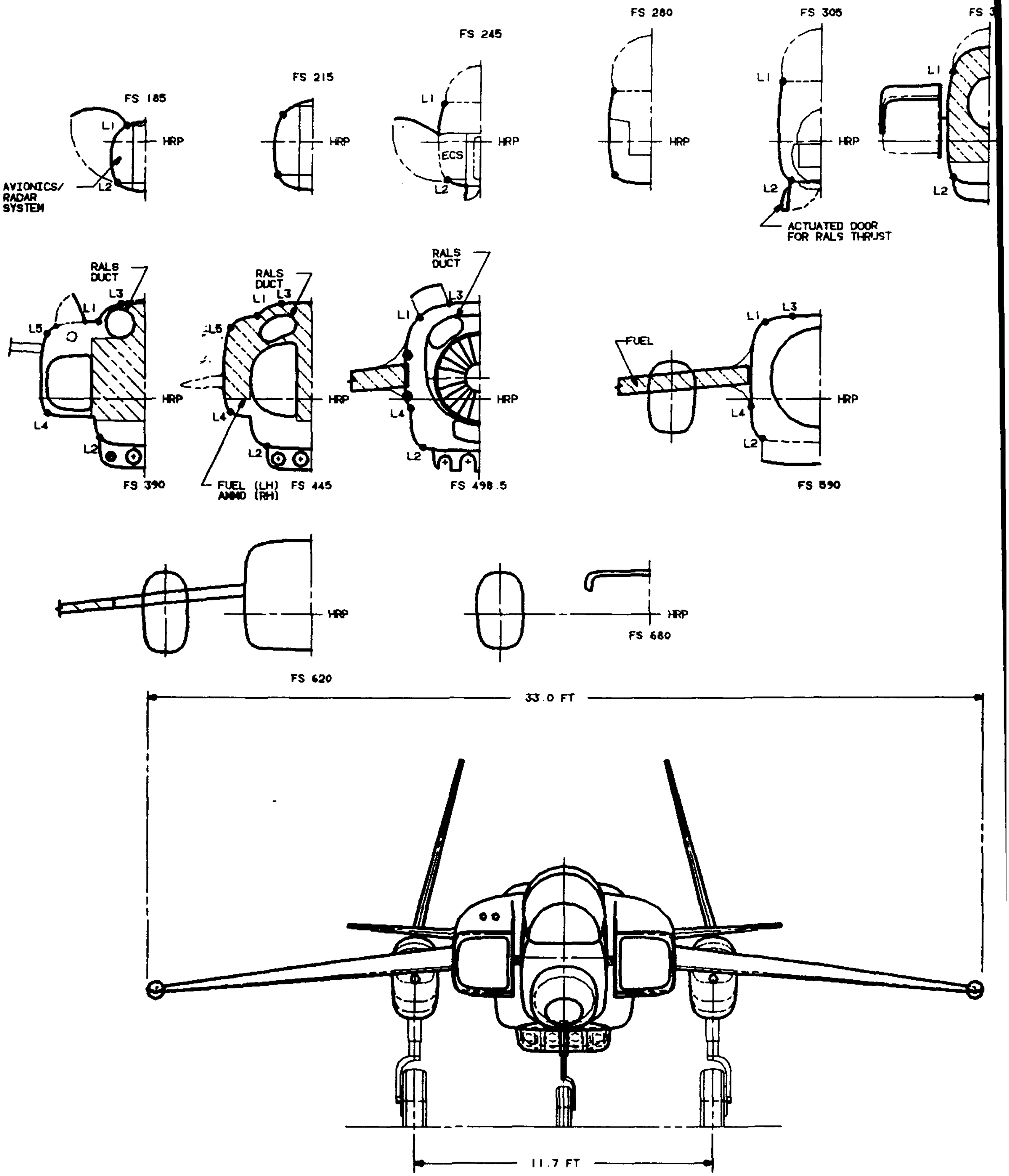
SECTION 2

ASTOVL FIGHTER STRUCTURE DESCRIPTION

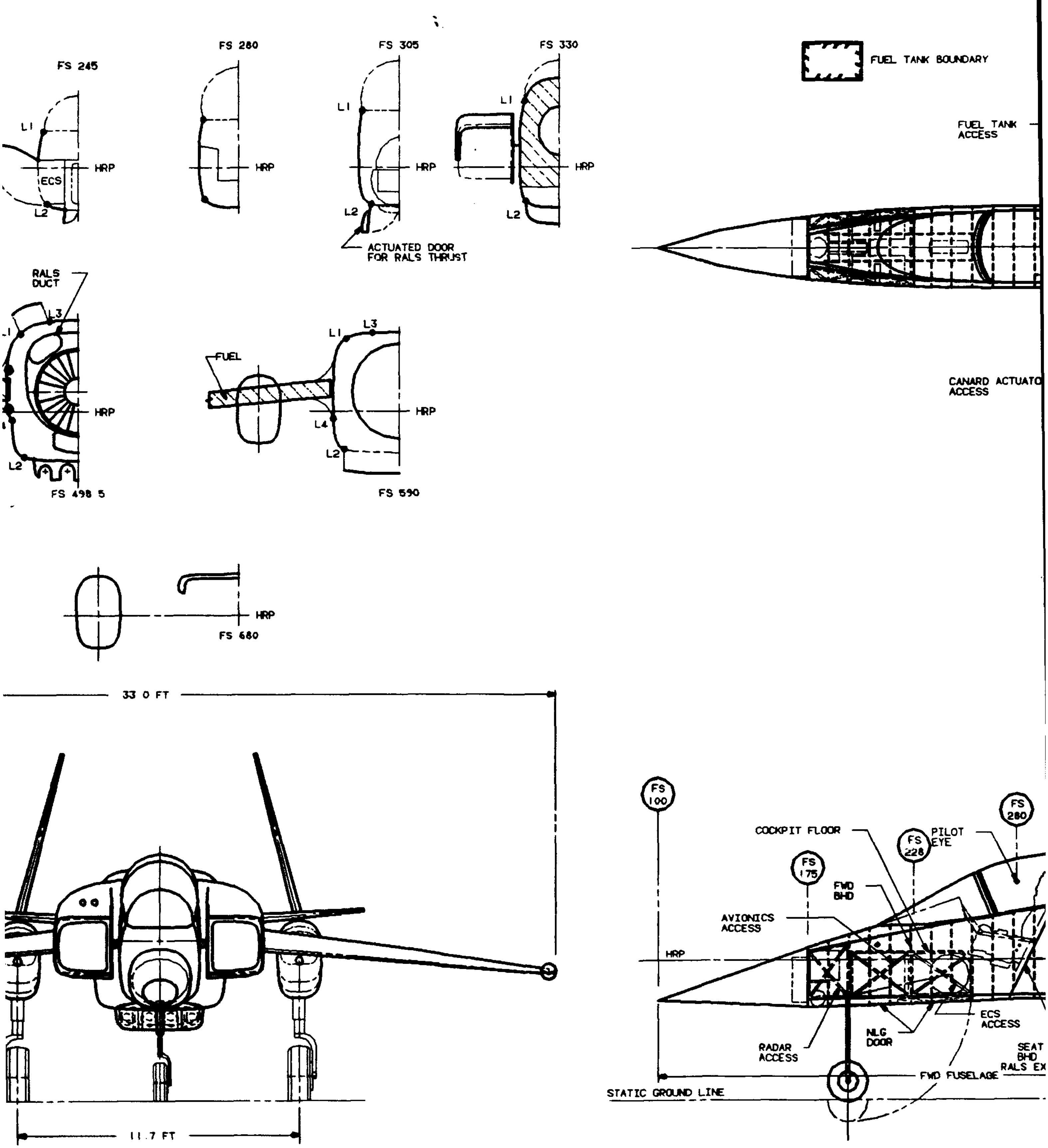
The Northrop N382-20 ASTOVL fighter is a state-of-the-art descendant of a family of horizontal attitude take-off and landing (HATOL) and vertical/short take-off and landing (V/STOL) aircraft. The N382 aircraft series is a single engine derivative of Northrop's N336 HATOL/VTOL fighter. Predecessors to the N382-20, such as the -12 and -18, were developed to meet basic mission and point performance goals, with the exception of supercruise in dry power. The N382-20 version satisfied the supercruise in dry power requirement through shortening of the fuselage. The configuration adjustments made were accomplished with the aid of Northrop's version of NASA's "Aircraft Synthesis" (ACSYNT) program.

The structural arrangement of the baseline ASTOVL fighter configuration is shown in **Figure 1**. This is a single-engine aircraft that takes off conventionally (with the addition of vectored thrust) in 600 feet, and can land vertically at the conclusion of the mission. It employs a Remote Augmented Lift System (RALS) turbofan propulsion system with vectorable nozzles aimed at providing the thrust needed for take off, vertical landing, and control during transition and hover. The fighter, designated by Northrop as Model N382-20, is a 28,000 lb class aircraft that carries two AMRAAMs and two ASRAAMs in an underfuselage conformal pod and a 20 mm gun with 500 rounds of ammunition. Basic dimensional data and significant characteristics of the ASTOVL fighter are presented in **Tables 1 and 2**.

The N382-20 is a canard-delta configuration composed of four major structural assemblies: (1) multiple-spar wings shoulder mounted to the fuselage; (2) fuselage of semimonocoque construction; (3) fully movable canards; and (4) two-wing nacelles that accommodate the landing gear, contain fuel, and support the vertical stabilizers.



FS 185
FS 215
FS 245
FS 280
FS 305
L1
L2
HRP
AVIONICS/
RADAR
SYSTEM
ECS
ACTUATED DOOR
FOR RALS THRUST
RALS
DUCT
L3
L4
L5
FS 390
FUEL (LH)
AMMO (RH)
FS 445
FS 498.5
FUEL
FS 590
FS 620
FS 680
33.0 FT
11.7 FT



FS 245
L1
HRP
ECS
L2
FS 280
HRP
FS 305
L1
HRP
L2
ACTUATED DOOR
FOR RALS THRUST
FS 330
L1
HRP
L2
FUEL TANK BOUNDARY
FUEL TANK
ACCESS
RALS
DUCT
L3
L1
HRP
L2
FS 498 5
FUEL
L1
L3
HRP
L4
L2
FS 590
CANARD ACTUATO
ACCESS
HRP
FS 680
33 0 FT
11.7 FT
FS 100
COCKPIT FLOOR
FS 228
PILOT
EYE
FS 280
FS 175
FWD
BHD
AVIONICS
ACCESS
HRP
ECS
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NLG
DOOR
RADAR
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SEAT
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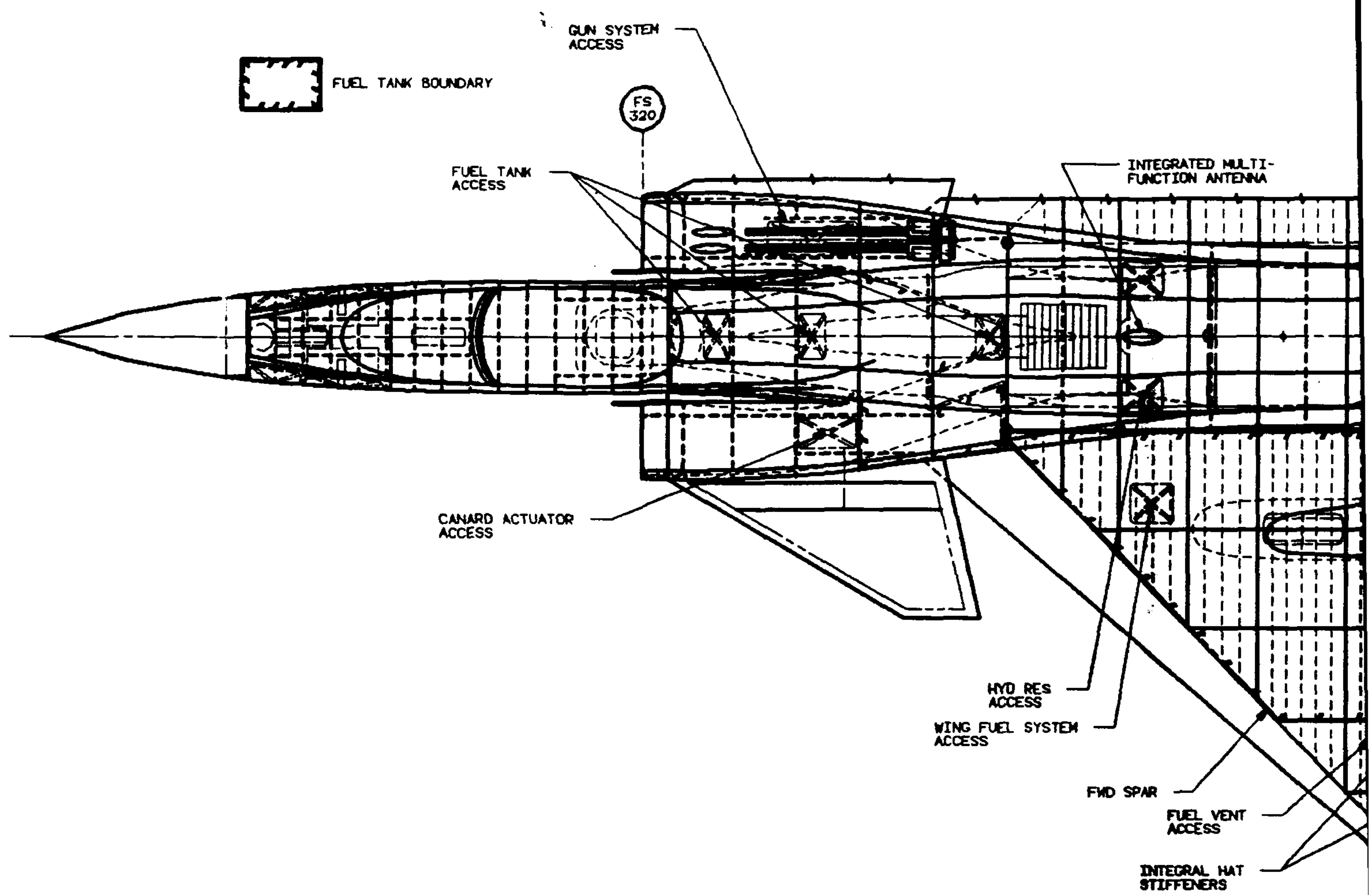
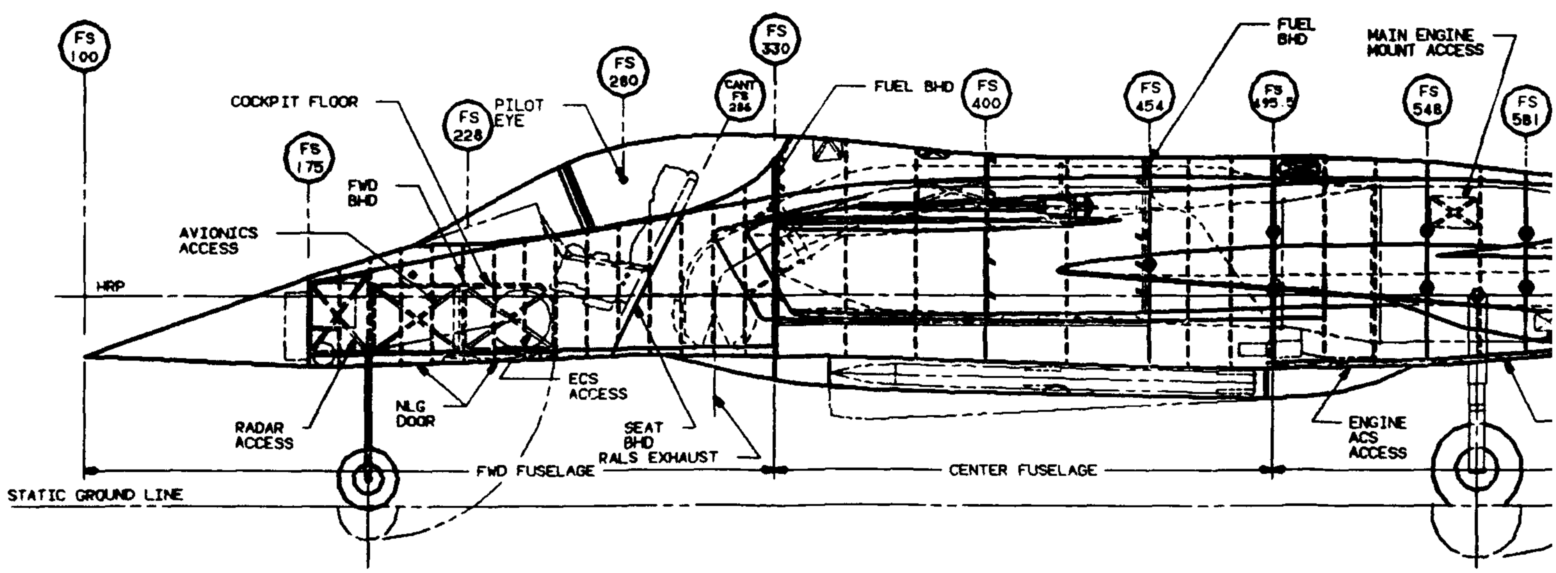
RALS EX
FWD FUSELAGE
STATIC GROUND LINE


GUN SYSTEM ACCESS
FUEL TANK BOUNDARY
FS 320
FUEL TANK ACCESS
INTEGRATED MULTI-FUNCTION ANTENNA
HRP
CANARD ACTUATOR ACCESS
HYD RES ACCESS
WING FUEL SYSTEM ACCESS
FWD SPAR
FUEL VENT ACCESS
INTEGRAL HAT STIFFENERS


FS 100
FS 175
FS 228
FS 280
CANT FS 286
FS 330
FS 400
FS 454
FS 495.5
FS 548
FS 581
COCKPIT FLOOR
PILOT EYE
FUEL BHD
FUEL BHD
MAIN ENGINE MOUNT ACCESS
FWD BHD
AVIONICS ACCESS
HRP
RADAR ACCESS
NLG DOOR
ECS ACCESS
SEAT BHD
RALS EXHAUST
FWD FUSELAGE
CENTER FUSELAGE
ENGINE ACS ACCESS
STATIC GROUND LINE

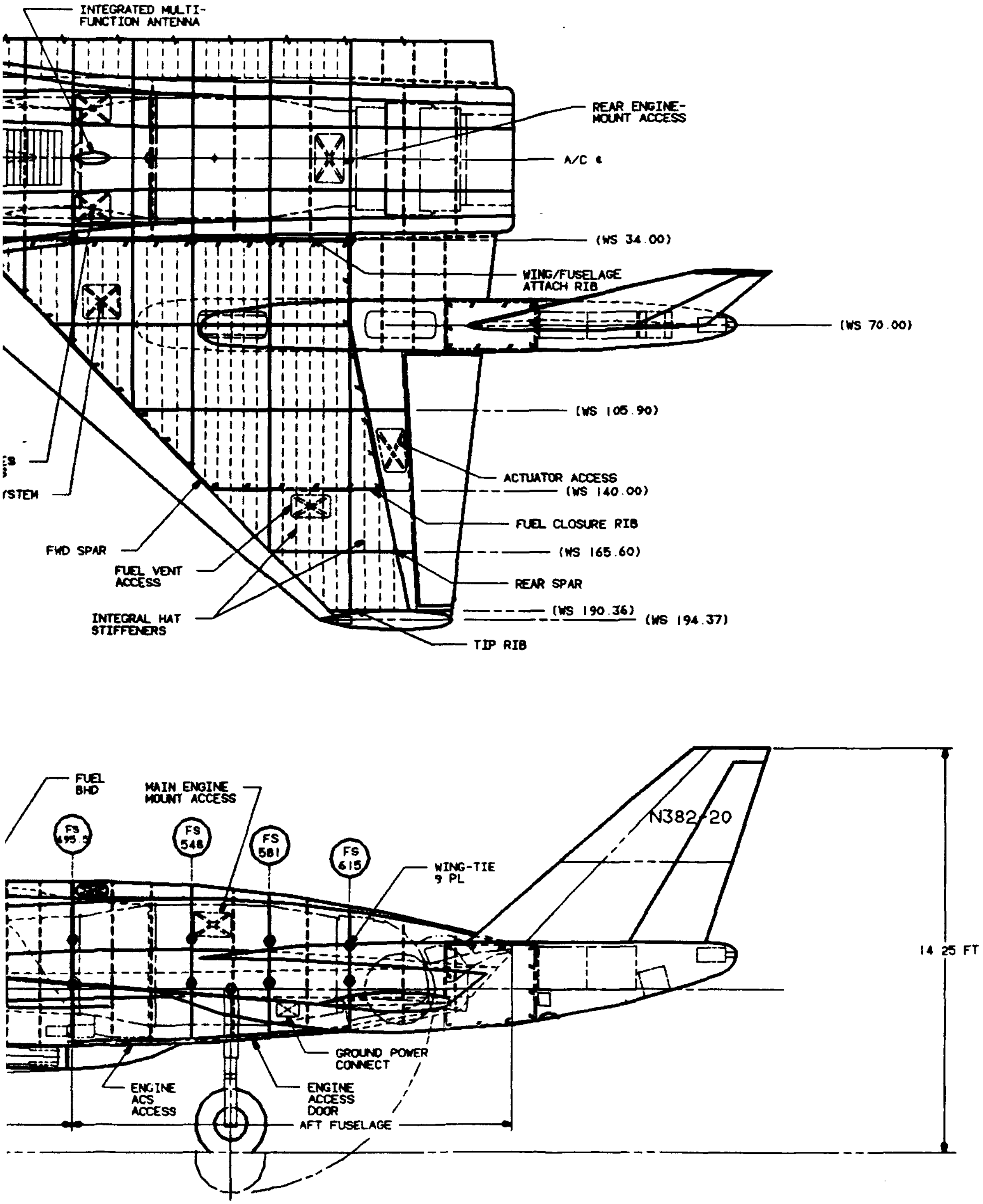


FIGURE 1 ASTOVL FIGHTER STRUCTURAL ARRANGEMENT

TABLE 1. N382-20 ASTOVL FIGHTER BASIC DIMENSIONAL DATA

BASIC SURFACES	UNITS	WING	CANARD	VTAIL
AREA (PROJECTED)	SQ FT	495.3	145.9	52.4
ASPECT RATIO	AR	2.1	2.0	1.4
TAPER RATIO	λ	0.18	0.15	0.28
THICKNESS RATIO, ROOT	T/C_{ROOT}	0.04	0.04	0.04
THICKNESS RATIO, TIP	T/C_{TIP}	0.04	0.04	0.04
L. E. SWEEP ANGLE	DEG.	50	60	47.5
C / 4 SWEEP ANGLE	DEG.	40.8	53.74	41.5
DIHEDRAL / CANT ANGLE	DEG.	-5.0	4.0	15
INCIDENCE ANGLE	DEG.	0	0	0
TWIST ANGLE	DEG.	0	0	0
SPAN (PROJECTED)	FT	32.4	16.9	8.5
ROOT CHORD	FT	25.9	14.9	9.7
TIP CHORD	FT	4.7	2.3	2.7
MEAN AERO. CHORD	FT	17.7	10.2	6.9

TABLE 2. N382-20 ASTOVL FIGHTER BASIC CHARACTERISTICS

PARAMETERS	UNITS	ASTOVL
WING LOADING (W / S)	LB / SQ FT	56.0
THRUST / WEIGHT RATIO (T / W) TAKEOFF, MAX. POWER		1.47
THRUST / WEIGHT RATIO (T / W) LANDING, MIL. POWER		1.37
GROSS TAKEOFF WEIGHT	LB	27,735
WING AREA	SQ FT	495.3
WING SPAN	FT	32.4
FUSELAGE LENGTH	FT	48.7
FUSELAGE EQUIV. DIA	FT	4.1
FUEL WEIGHT	LB	8,246
ENGINE SCALE FACTOR		1.103
ENGINE SL STATIC THRUST	LB	42,349
ENGINE DIAMETER	FT	4.1
ENGINE LENGTH	FT	15.5
CRUISE LEG, SUBSONIC	N. M.	100
CRUISE ALTITUDE (AVG)	FT	43,000
CRUISE LEG, SUPERSONIC	N. M.	50
CRUISE ALTITUDE	FT	35,000

The major wing components consist of a multispar structural torque-box (which also serves as an integral fuel tank), fixed leading edge, and trailing edge flaperons. For the torque box in the current design, the wing attaches to the fuselage carry-through bulkheads by means of clevis lugs and bolts. The attachment at the front spar reacts only the wing vertical shear while the remaining attachments react the wing bending moments as well as vertical shear loads. The wing torque box skins are configured as solid composite laminates integrally stiffened with spanwise hat-section stringers. This design provides the minimum weight for a postbuckled structure. The composite spars are located perpendicular to the aircraft centerline. This design provides efficient load transfer from the wing spars to the fuselage wing lug fittings. The perpendicular spar configuration (at 36-inch nominal spacing) facilitates optimum placement and spacing (approximately 6.0 inches) of the integral hat stiffeners from the root rib to the tip rib. The spanwise stiffeners efficiently reduce the effective panel width of the covers and reduce the number of spars required.

The ribs are provided for additional buckling stability as well as for reacting fuel pressure and air loads. Fuel pressure and vent lines penetrate the ribs and spars through necessary cutouts. Gravity fuel flow holes are also incorporated in the intermediate ribs and spars as required. Peripheral sealing of the integral fuel tank is incorporated in the boundary spars and ribs. The Reaction Control System (RCS) which maintains roll control during hover has ducts running through the leading edges (immediately forward of the front spar) to reaction control valves located in each wing tip.

The center fuselage is joined to the forward and aft sections at Fuselage Station (FS) 330 and FS 495.5, respectively. There are 11 major bulkheads in the fuselage including the five wing carry-through bulkheads in the aft fuselage. There are four major longerons per side. The forward fuselage section is comprised of three areas: the nose cone, the crew station, and the transparencies. The pressurized crew station structure is made up of the cockpit sides, the canopy, the canted FS 286 seat support bulkhead, and the crew station floor. Finally, an integral fuel tank and a spindle mounted canard (located above the engine inlet) are located in the center fuselage.

SECTION 3

N382-20 ASTOVL FINITE ELEMENT MODEL

The following subsections provide a description of the ASTROS model development, guidelines, and assumptions as required for enabling independent repetition of the ASTROS structural optimization and analysis performed during this contract. Appendices A through E give additional details on the model and its execution.

3.1 GENERAL MODEL DESCRIPTION

The N382-20 ASTOVL finite element model is a right half model of the complete vehicle with centerline-plane symmetry boundary conditions (BCs). The initial size target for the model was 1000 GRIDs and 1000 to 1500 elements. The bulk of the model is skin and other light gage structure, so the predominant elements are plate and shell types. Because ASTROS does not resize bending capable plate/shell elements, the model was configured with membrane only quadrilateral and triangular plates. Principal axial load carrying members were idealized as RODs. **Figure 2** shows the complete ASTROS/NASTRAN model of the N382-20 ASTOVL vehicle. The key structural components are identified and located relative to the rest of the structure. The sections are broken down according to the major manufacturing joints.

The goal of ultralightweight motivates in seeking minimum weight solutions for the complete structure. Therefore the initial intention was to represent the entire airframe structure as eligible for redesign and request that ASTROS specify the element thickness and areas everywhere. The exceptions to this were the vertical stabilizer, the canard, and the landing gear. Engines and equipment were taken as fixed in size and mass.

The all-moving canard was full-depth honeycomb construction with spindle and assumed the vertical fin was of multi-rib construction. The vertical stabilizer is modeled as a simplified beam structure with the correct

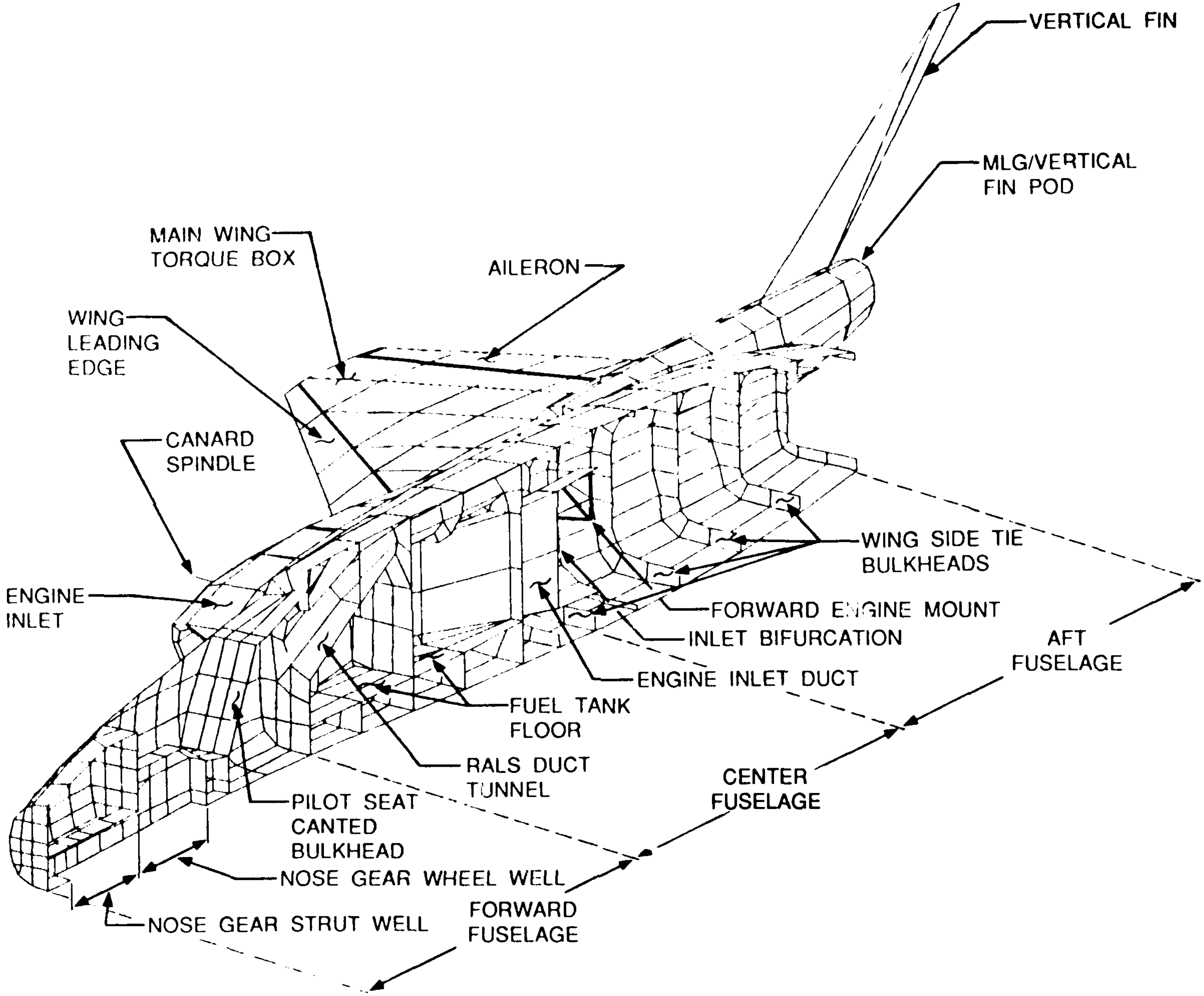


Figure 2. N382-20 ASTOVL ASTROS/NASTRAN Model

mass; while the canard is modeled as the spindle only, with correct mass and with aerodynamic loads applied at the spindle tip. Local design details of either part were assumed to only lightly affect the rest of the vehicle structural design.

The vehicle airframe components defined as primary structure were modeled. This included:

- skins
- longerons
- bulkheads
- spars
- ribs
- inlet ducting

Access panels in the fuselage are typically modeled by shear panels i.e., shear load capability only. For this analysis, to maintain simplicity by minimizing the number of element types in the model, access panels were simulated as QUAD4 membranes (used for the fuselage side skin panels) and defined as ±45° layups. This effectively reduces the axial load carrying capability to a minimum. Although the nose gear door is represented as a cutout, the main landing gear door is assumed fully effective. Torsional and bending stiffness of the MLG pod is so critical for flutter resistance that we assumed shear load transfer would be possible through the latch mechanisms.

Some frames and stiffeners were lumped to keep the size of the model within the target range. Although the cost of running the model was negligible in computer charges, the execution time was very long on the government furnished MicroVAX II processor. A large size model may represent the structure more faithfully, but at the expense of truly excessive execution times; as is shown in Appendix A.

3.2 ASTROS FINITE ELEMENT OPTIMIZATION

Some knowledge by the reader of NASTRAN is anticipated. Since ASTROS is still relatively new, however, a brief description follows. It is

noted in this discussion, the terms design and optimization are used interchangeably.

The ASTROS (Automated STRuctural Optimization System) procedure provides a multidisciplinary analysis and design capability for aerospace (and other) structures. The engineering analysis capabilities of the system include structural analysis (static and dynamic), aeroelastic analysis (static and dynamic), and automated design. A specifically designed data base and executive system were implemented to maximize the system's efficiency, flexibility, and maintainability.

The structural portion of the ASTROS system was based on the NASTRAN finite element software with a truncated element library. The static aerodynamic portion was derived from USSAERO and flutter was assembled from NASTRAN, FASTOP, and code developed at Northrop (References 1 through 6). Much of the design related code was developed at Northrop including the design and constraint sensitivities and the design variable linking. The routine which does the optimization, MicroDOT (or simply the optimizer), uses math programming techniques to solve a minimization/maximization problem with design variables and sensitivities, subject to constraints and side constraints (References 7 and 8). The standard executive sequence was written to handle design with multiple analysis disciplines simultaneously.

Northrop's version of the NASA ACSYNT program, an analogous automated design tool for conceptual design, was used to determine the ASTOVL configuration, engine characteristics, fuel weight, and empirical structural weight. These were determined to meet the specified mission and performance requirements. The ACSYNT output of size, details, and weight target formed a part of the input to ASTROS.

ASTROS is a preliminary design tool. Within the sequence of events in the design process for an aerospace vehicle, preliminary design takes the configuration determined in the conceptual design phase and sizes the structure within this envelope. Therefore, preliminary design should not and ASTROS does not do shape optimization. The coordinates of the GRIDs are not changed during redesign. The design quantities are the thicknesses of two-dimensional

plate/shell elements and the areas of one-dimensional RODs and BARs. Three-dimensional elements are available in ASTROS but are not designed since this can only be done with shape optimization.

Structural optimization with ASTROS involves specifying a certain portion of the model as "designed" and constraining the behavior of the model within certain calculated limits for the requested disciplines. The program adjusts the design variable quantities (thickness of 2-D elements, and areas of 1-D elements) for each iteration to yield a minimum weight solution which satisfies all the constraints. The designed weight of the model is calculated by multiplying the densities on the material cards times the volumes (thickness*areas of 2-D elements or areas*lengths of 1-D elements) for the designed elements during execution.

The constraints available in ASTROS include:

- stresses and strains within the strength allowables
- deflections - maximum and minimum
- frequencies - maximum and minimum
- aileron and lift effectiveness for the SAERO discipline, - maximum and minimum
- flutter damping - maximum
- thickness/area - maximum and minimum

The principal strength of ASTROS is that these constraints can be applied over a range of boundary conditions (e.g., symmetric and antisymmetric), flight conditions and load conditions. Hence, the optimum structure does not represent a point optimum but one that is feasible throughout the flight envelope.

3.3 FINITE ELEMENT PROGRAM AND MODEL INTERACTION

The ASTOVL finite element model developed in this study was keyed to the ASTROS optimization solution. The following discussion is for the ASTROS model as opposed to a NASTRAN model. While NASTRAN requires the element thickness be defined ahead of time, with many property type cards (at least one

card for each thickness for a given material), ASTROS can take what could be a single property card for all elements referencing a particular material and specify the thickness variations on separate SHAPE function inputs. This shape function approach allows smooth variation in thickness along directions, rather than the thickness steps resulting from grouping elements into regions of constant thickness.

The compatibility of ASTROS with NASTRAN permits conversion from NASTRAN to ASTROS with relative ease. But the unique features of ASTROS make it difficult to convert back to NASTRAN; particularly the new design after at least one iteration of an optimization run. The shape function design variable linking feature in ASTROS allows the input property definitions of each element to be different from all others, with as few as one property card referenced on all the linked elements.

In anticipation of this situation, only a few nominal-value property cards were defined for the entire vehicle. The ASTROS determined thicknesses are key output results. The shape function form of the thicknesses are not, however, currently tabulated in a NASTRAN readable form so generating a NASTRAN equivalent model is not a trivial problem. Shape functions were chosen because: (1) they represent smoother thickness variations than the physical (PLIST) linking option; and (2) with PLISTs, an a priori knowledge of the final thickness distribution is implied.

The procedure was to set up a model in NASTRAN for the geometry and elements. This permits verification and graphic debugging of the model using Northrop's NCASA pre- and post-processor. NASTRAN also offers capabilities such as AUTOSPC and GRID POINT WEIGHT GENERATOR which are not in ASTROS. The output from AUTOSPC must be manually input to ASTROS to eliminate singularities from the stiffness matrix. The NASTRAN model was transferred to the MicroVAX II computer that has the development version of ASTROS resident. Subsequently, the membrane only PCOMP properties for composite materials, aerodynamic inputs, design variables (DESVARs), SHAPE functions, and flutter inputs were added to complete the model for proper optimization execution.

3.4 ASTROS FINITE ELEMENT OPTIMIZATION MODEL DEVELOPMENT AND DESCRIPTION

The finite element modeling philosophy and development were driven by the requirements of ASTROS optimization. Two rules-of-thumb followed in performing optimization with ASTROS, which strongly influenced the make-up of the model are:

Maximum number of design variables	~200
Maximum retained constraints	~100 + Minimum Gage Constraints

These are not hard and fast rules, but rather guidelines to a smooth and hopefully expeditious execution of the program. Large numbers of design variables and retained constraints not only increase execution time but may also tend to confuse the optimizer. Large magnitude differences in sensitivities of the design variables and constraints can cause numerical ill-conditioning. Too many retained constraints may overly restrict movement of the design point (i.e. the design gets "boxed in").

An infeasible initial design can be handled by math programming, but a feasible design is easier for the optimizer to start from. Generating a feasible initial design is not as simple as thickening all the elements to generate large margins of safety and low deflections if flutter is involved. Flutter is not something we can intuitively eliminate, certainly a stiff structure is not always going to raise the flutter speed.

We wish to supply the optimizer with a general design model that will allow it to find the lowest weight structure. Aircraft construction is in fact a highly optimized operation based on years of practical experience and study. Thickening parts locally for concentrated loads, cutouts, and attachments is standard practice. This kind of small scale detail is not reasonable within ASTROS and it points up the challenge of out-performing the traditional design approach.

The limit on design variables has a major impact on the design model specifications. When composite materials are used, each ply in an element requires a separate design variable. With extensive use of composites in a large

model such as the complete ASTOVL vehicle, the number of design variables can easily exceed the 200 level. To restrict the number of design variables, compromises were made in the assumptions on the use of composites in significant portions of the structure. Having used 74 wing design variables already and remaining within the design variable limit of 200, regions in the all-composite fuselage were divided into just 2 shell/plate element properties:

1. Quasi-isotropic - top and bottom skins, bulkheads & frames
2. 100 percent 45 degree "fabric" - side skins (primary shear structure)

The elements in the fuselage were, as a result, all "single ply" composite layups. Modifications to the input data to deviate from these simplifications can be performed and are recommended to test the sensitivity of the assumptions. The total number of fuselage design variables was 92 when all the elements were summed. Increasing the number of plies in each fuselage element by 1 would add more than 50 percent more design variables.

Fuselage skins are usually buckling critical, and since ASTROS does not consider buckling, minimum gage limits were expected to be critical. Buckled skins would not carry their fair share of the bending loads, so the side skins were defined by ±45° plies. This was done to minimize their contribution to the fuselage bending moment of inertia. Longeron loads are carried in pure tension/compression so the required area to carry the load tends to be fairly low. Local crippling, however, is often the critical failure criterion for longerons. Crippling constraints should be accommodated eventually in ASTROS. Fully effective skins (i.e., unbuckled) will tend to over-estimate their load sharing fraction and also make the longeron areas unrealistically low.

The wing structure has 74 design variables and does retain 4 ply directions on each of the upper and lower skins. The substructure is again "single ply" composite elements. The biaxial nature and magnitude of the wing skin loads, including the shear induced from wing twist, make the 4 ply skin elements an effective use of many design variables.

Half the wing skin DESVARs can be eliminated if the skins are specified as having the same layup for the upper and lower surfaces. Likewise 25 percent of the variables can be eliminated if a balanced ±45 degree layup is specified.

The minimum gage constraints specified on the DCONTHK cards are necessary for shape function linking. The DCONTHK forces retention of the minimum gage constraint on specified elements to prevent the optimizer from driving element thicknesses to negative values. The individual design variable quantities can have negative values as long as the sum of all shapes for a given element is a positive number. In general, to prevent negative thicknesses, one element for each shape associated with that group of elements has a DCONTHK defined. The location of the constrained elements within the group plays an important role; a poor location of elements requires more constraints.

Actual minimum gage values assigned on the PCOMP cards were 0.010-inch for each of 4 ply directions on the wing skins and 0.040-inch for all of the remaining components. The 0.010-inch thickness corresponds to roughly two plies of unidirectional tape and 0.040-inch to eight plies. These minimum gages are realistic for manufacturing/handling but probably are not sufficient for damage tolerance.

3.4.1 Loads and Design Criteria

The Structural Design Criteria (SDC) are based on the traditional factor of safety concept. Here the loads are calculated for limit load factors and are then multiplied by 1.5 to obtain ultimate loads as used for design and static strength testing.

This statically unstable airplane will necessarily depend entirely on a Stability Augmentation System (SAS). No consideration of SAS effects are included in these preliminary static strength load estimates. SAS will modify the load distributions and their random cyclical repetitions and reversals. Providing for service life requirements, repeated loads, damage tolerance analysis, fail-safe, and safe-life will effectively increase the static

strength of the structure and the actual factor of safety. The V-N envelope (**Figure** 3) and load summaries shown in **Figure** 4 are conservative estimates and can be used for qualitative comparisons. **Figure** 5 shows the design flight envelope.

Control lifting surface load calculations are approximated abrupt maneuver and check conditions. These conditions produce more severe loads than those resulting from steady state rolling pull-up turns to the design limit normal load factor. During maneuvers, the wing has to lift the downward canard loads. Military specifications require arbitrary factors on tail loads since pure symmetrical loadings do not occur in practice. Spanwise distributions are available for the exposed surface root shear and bending loads summarized in **Figure** 4.

These loads (**Figure** 4) are separate from the applied airloads calculated in ASTROS. The printed output of steady airloads currently available from ASTROS are for a rigid structure, the actual aeroelastically corrected loads are not. Since they do not include the aeroelastic corrections, no load output was requested, nor can the pressure loads be integrated to yield bending moment, shear, and torque diagrams for fuselage or wing.

Converting overall vehicle maneuver accelerations measured at the center of gravity to local accelerations is based on rigid body dynamics:Rigid Body Load Factors at a Remote Point from the Center of Gravity

$$\begin{Bmatrix} M_x \\ M_y \\ M_z \end{Bmatrix} = \begin{Bmatrix} M_{x_{cg}} \\ M_{y_{cg}} \\ M_{z_{cg}} \end{Bmatrix} + \begin{bmatrix} -(Q^2+R^2) & (PQ-\dot{R}) & (PR+\dot{Q}) \\ (PQ+\dot{R}) & (P^2+R^2) & (QR-\dot{P}) \\ (PR-\dot{Q}) & (QR+\dot{P}) & (P^2-Q^2) \end{bmatrix} \begin{Bmatrix} \frac{X}{g} \\ \frac{Y}{g} \\ \frac{Z}{g} \end{Bmatrix}$$

where,

Mx, My, Mz - Aircraft Linear Load Factors along body axes, g's

P, Q, R - Angular Velocities: Roll, Pitch, Yaw about body axes, rad/sec

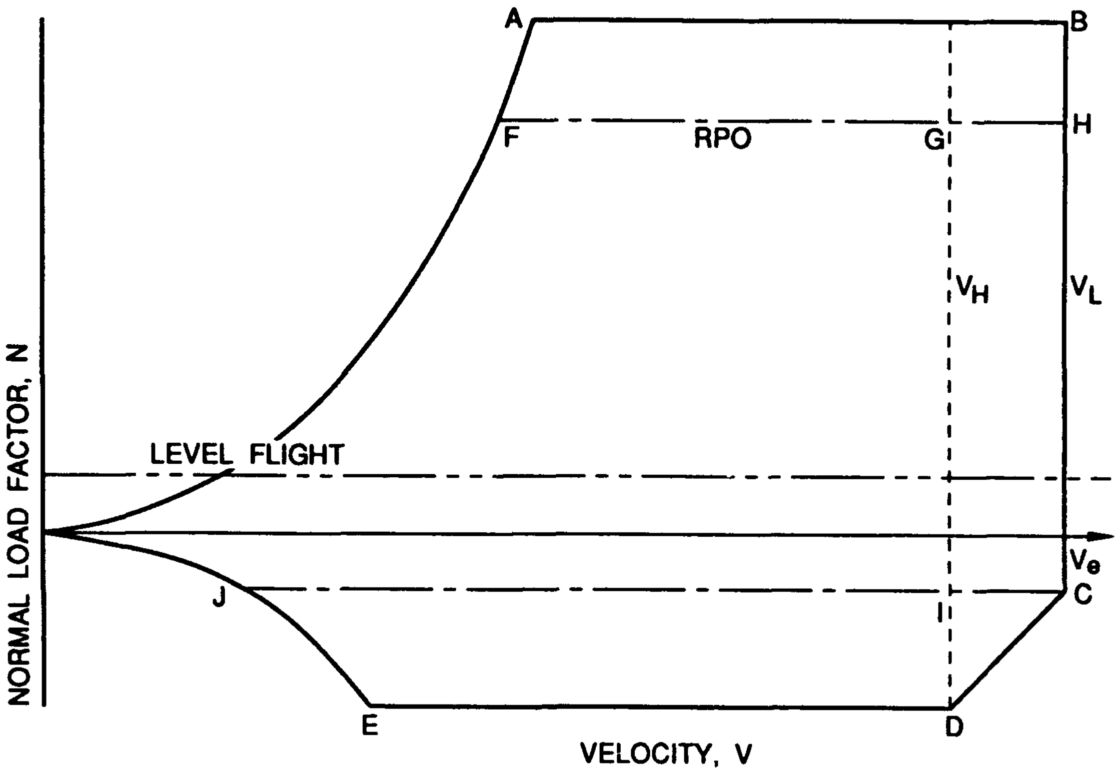


Figure 3. Schematic V-N Flight Envelope Diagram

V-N DIAGRAM POINT	H (1000 FT)	M	LIMIT NORMAL L. F. (G)	SHEAR (LBS)	BENDING (IN-LBS)	EXPOSED SPAN (IN)	SPAN ROOT (IN)
A-WING UPBENDING	5	0.6	9	117,120	7,172,030	151.36	B. P. 44
D-WING DOWNBENDING	5	0.9	-3	-50,810	-3,110,610	151.36	B. P. 44
A-CANARD* DOWNBENDING	5	0.6	9	-9,470	-178,860	50.02	B. P. 41.18
D-CANARD** UPBENDING	5	0.9	-3	9,620	177,150	50.02	B. P. 41.18
A-WING RPO DOWNGOING SIDE UPBENDING	5	0.6	36/5	99,500	6,096,200	151.36	B. P. 44
G-RPO VERT TAIL	0	0.9	36/5	±8,450	±242,770	70	W. P. 25.2

Figure 4. Preliminary Ultimate Wing Root Loads

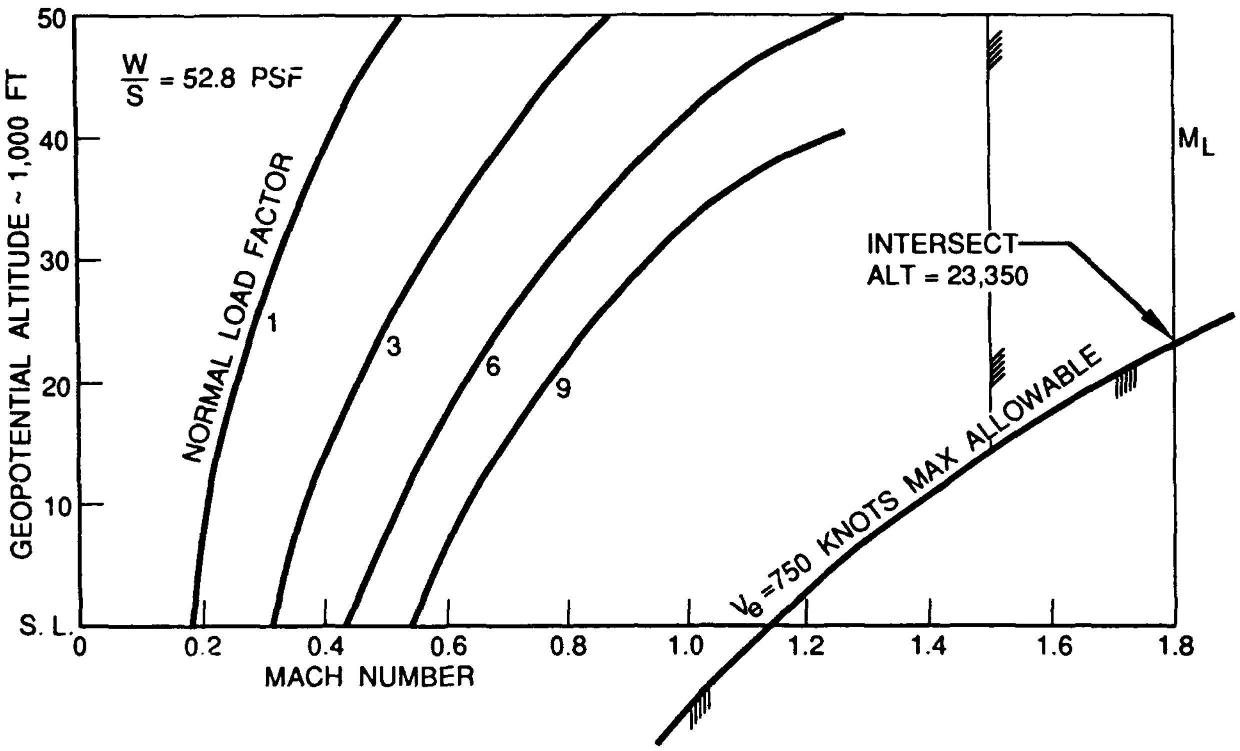


Figure 5. Design Flight Envelope

$\dot{P}$, $\dot{Q}$, $\dot{R}$ - Angular accelerations: Roll, Pitch, Yaw about body axes, rad/sec**2

X, Y, Z - Linear distances along the body axes to a remote point measured from the C.G.

g - Acceleration of earth's gravity - 386.09 in/sec**2

This equation is included in the inertia relief formulation within ASTROS and NASTRAN.

3.4.2 Flight Loads Criteria.

Figure 3 showed the flight envelope for the ASTOVL. The corner points of the envelop are defined in **Figure** 4.

With antisymmetric loads assumed less critical and asymmetric aerodynamic conditions unacceptable to ASTROS, the following flight conditions were chosen for optimization:

Mach 0.7	Sea Level	9g	symmetric pull-up
Mach 1.5	Sea Level	9g	symmetric pull-up
Mach 0.7	Sea Level	-3g	symmetric push-over

Sea level altitude calculations were chosen because they result in the largest aeroelastic corrections.

Subsequent test runs revealed a major ASTROS fault in the supersonic SAERO routines which overestimated the internal loads. Therefore, the Mach 1.5 9g load case was dropped.

3.4.3 Ground Loads Criteria.

ASTOVL aircraft experience higher landing sink speeds than conventional land-based aircraft. They are designed to operate from battle damaged and semi-prepared runways. Consequently, design sink rates fall between those for carrier based and commercial transport airplanes. The following equations are used to determine the loads for various sink rates and landing gear stroke lengths. Landing gear loads vary inversely with stroke length. Loads approach infinity as the stroke decreases to zero.

For vertical takeoff airplanes the design landing weight is the gross takeoff weight because a landing may be a failed takeoff. The main gear and nose gear "support" dynamic effective masses. These masses and impact loads are based on a one-dimensional dynamic model: rigid airframe on gear strut springs.

$$\text{Dynamic Mass} = \frac{K_{yy}^2}{K_{yy}^2 + \Delta x^2} * \text{Static Mass} \tag{1}$$

where,

K_{yy} = radius of gyration of aircraft about y axis through CG

Δx = distance from CG to gear along the station direction

Landing Impact Force is calculated from the formula:

$$F = \frac{\frac{1}{2}mv^2}{(S*K)} = \frac{\text{Kinetic Energy}}{(\text{Stroke Length} * \text{Constant})} \qquad (2)$$

where,

m = Dynamic effective mass

v = landing sink speed

K = 0.7 for typical fighter strut damping levels

To evaluate the landing impact forces we need the vehicle mass and dimensional properties:

N382-20 ASTOVL Mass Properties: per weight statement (Appendix B) and NASTRAN grid point weight generator output for the mass moment of inertia.

Gross Weight: nominal gross (Note: Only the full fuel condition was considered).

$$28134 \text{ lb}_{mass} = 72.89 \text{ lb}_{force} \text{ sec}^2/\text{in} = 874.6 \text{ slugs}$$

Static Weight Distribution:

Nose gear	6691 lb	23.8%
Main gear	21443 lb	76.2%

Locations:

	Station	Water Line
Nose Gear	195	0
Center of Gravity	477	67
Main Gear	565	0

Pitch Mass Moment of Inertia: Iyy

$1.25\text{x}10^6 \ lb_{force}\text{-}sec^2\text{-}in = 104,000 \ slug\text{-}ft^2$

Pitch Radius of Gyration: Kyy

$Kyy^2 = Iyy/M = 17113 \ in^2$

Dynamic mass (per Equation 1) is shown in Table 3.

TABLE 3. DYNAMIC MASSES FOR GROUND LOAD CONDITIONS

DYNAMIC MASS			
	FRACTION OF GROSS MASS	$LB_f \ SEC^2/IN$	SLUGS
NOSE GEAR	.171	12.46	149.6
1/2 NOSE GEAR	.0855	6.23	74.8
MAIN GEARS	.6885	50.18	602.
EACH MAIN GEAR	.3442	25.09	301.

(For the right half symmetric model, there is only one main gear and only half the effective load from the nose gear was applied.)

Using conservative sink speed and stroke parameters defined for limit conditions (per Equation 2):

18 ft/sec landing sink speed (high value for STOVL aircraft corresponds to a glide slope of 4 degrees at 150 knots).

11 inch stroke nose gear ->	18888 lb (limit)	on 1/2 aircraft
->	28331 lb (ultimate)	on 1/2 aircraft
17 inch stroke main gear ->	49172 lb (limit)	on each strut
->	73758 lb (ultimate)	on each strut

Nose Gear Taxi loads: 3g's bump with simultaneous 0.55g braking

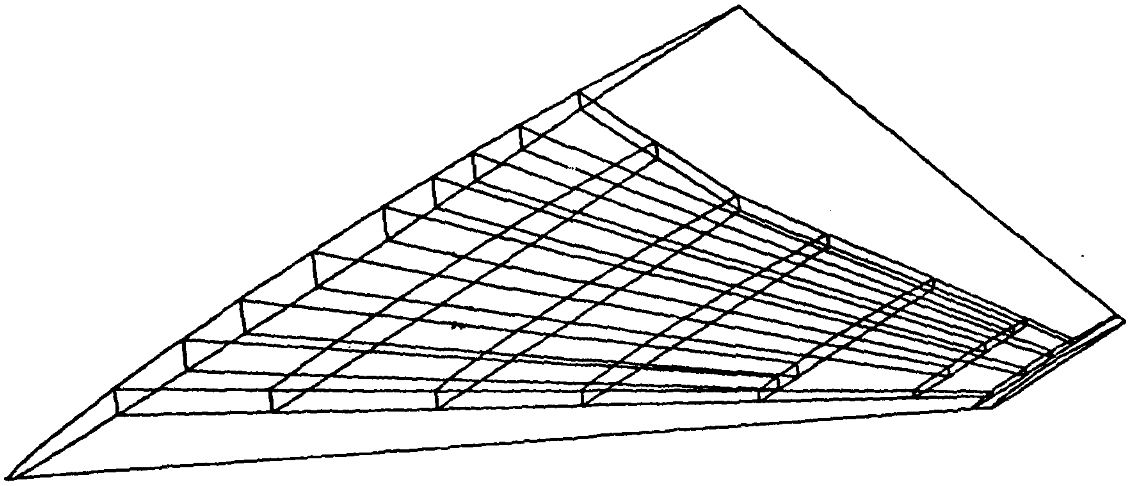
$$3 * \frac{6659}{2} + 0.55 * \frac{(28134)}{2} * \frac{(\ 67\ )}{370} = 9988.5 + 1401 = 11389 \text{ lb (limit) on } \tfrac{1}{2} \text{ aircraft}$$

Therefore, taxi loads are less critical than landing impact loads for the nose gear and were not included in the static load cases.

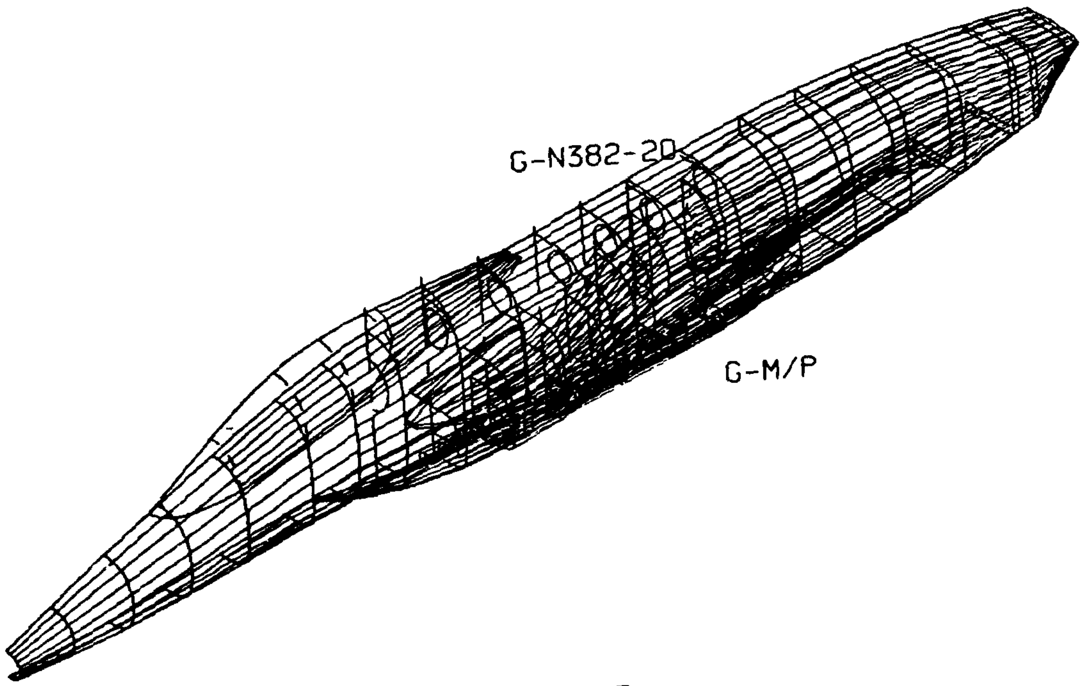
3.5 MODEL GENERATION

The engineering drawings for the N382-20 were generated with CADAM computer aided design software. **Figure 1** shows the three view CADAM drawing. All the individual fuselage and pod sections plus the wing and canard airfoil sections were transferred electronically to NCAD, Northrop's three dimensional computer aided design system. OML and internal surfaces were modeled by running parametric cubic splines over the sections. **Figure 6** shows a wire frame representation of the NCAD fuselage and wing surfaces.

These surfaces were then used to form the finite element mesh. Planes defining internal structure were intersected with the OML surfaces to locate the nodes and edges of finite elements. The large structures and their intersections were located first - OML skins, longerons, and internal bulkheads, frames, and floors. The regions between the large structure intersections were discretized to give a consistent element size.



G-WING



FUSELAGE

Figure 6. N382-20 3-D NCAD Model (LH Side)

Once the structure was completely surfaced and intersected, the surfaces were converted to rational patch surfaces. In the NCAD system, rational patches are output directly into NASTRAN GRIDS and quadrilateral and triangular finite elements. This geometry is input into NCASA, Northrop's computer aided structural analysis software, where the balance of the geometric data is handled interactively.

3.5.1 Physical Phenomenon Simulated

There were three fundamental physical phenomenon simulated with the ASTROS finite element model:

Steady aerodynamics

- Maneuver loads on wing, fuselage, and canard for symmetric pull-up and push-over with aeroelastic correction.
- Trim angle of attack and elevator deflection.
- Aerodynamic stability coefficients.

Static Loads

- Rigid aeromaneuver loads as checkout only (from REVWING).
- Quasi-static landing impacts on the nose landing gear and the main landing gear.

Flutter at Mach 1.5

- Dynamic analysis: mode shapes and frequencies.
- Unsteady aerodynamic calculations.
- P-K flutter solution of coupled aerostructural equations.

3.5.2 Element Selection Rationale

Semimonocoque airframe structures are built up from thin gage detail parts. Plate and shell type finite elements are the best elements to represent

this construction. Beam and three-dimensional elements are used to simulate the heavier detail parts such as engine mounts and landing gear struts. The N382-20 model was configured to have all of the structure subject to redesign by ASTROS. The entire designed portion of the structure is composed of plate/ shell and rod elements. Because the ASTROS implementation of designed shell elements does not support bending stiffness, membrane only properties were required.

The elements selected for the different types of structure are:

1. Fuselage shell structure and wing substructure - QUAD4/TRIA3 - with primary shear loadings, the improved shear accuracy of the QUAD4 element is important for these structures.

2. Fuselage frames and bulkheads - QUAD4/TRIA3 - as shear load and concentrated loading redistributors, the improved shear accuracy of the QUAD4 element is important for these structures.

3. Wing skins - QDMEM1/TRMEM - with primary tension/compression loadings, the improved shear behavior of the QUAD4 is not necessary, plus at this stage of the ASTROS program development, the QDMEM1 element type is more reliable and somewhat faster to execute than the QUAD4.

4. Longerons - ROD - Local bending as available with BAR elements is not critical for large shell structures.

5. Cutouts, doors, and stringers - were not modeled discretely, for simplicity and execution time expediency.

3.5.3 Justification for Model Coarseness/Fineness

For preliminary, full-vehicle multidisciplinary studies, 1000 GRIDS and 1000 elements yield acceptable run times, allow consistent element sizes while representing faithful structural shape, and generate realistic load paths/distribution. At the same time they allow quick changes to the model. This level of mesh refinement does not allow for local detail which is inappropriate for preliminary design.

3.5.4 Explanation of the Choice of Boundary Conditions

We have a half model of the full vehicle. Symmetric maneuvers are the primary load cases; therefore, only mid-plane symmetric loads were analyzed. Antisymmetric loads rarely size significant structure except for local areas. Symmetric pull-ups and push-overs are the largest loads applied in the flight envelope; developing the maximum wing and fuselage vertical bending moments.

Antisymmetric yaw loads size the vertical and rudder areas and antisymmetric rolls design the aileron region. Although maximum fuselage lateral bending occurs from the yaw load, the structure is more critical for vertical bending loads.

The model can accommodate antisymmetric steady aeroelastic and static analyses with only minor additions. This is done by applying SPCs in the 1,3, and 5 directions (i.e., X, Z, and Pitch) along the centerline plane and scheduling a SAERO solution request for the desired aileron deflection.

ASTROS SAERO and Solution Control do not permit analysis of general asymmetric flight loads. Any asymmetric load can be separated into symmetric and antisymmetric portions. Each portion can be applied to a half model structure with the proper boundary conditions. NASTRAN Solution Control then has the option to do a SUBCOM, i.e., subcase combination where left- and right-half internal loads are computed. Right half loads are found by adding the symmetric and antisymmetric parts, while left hand loads result from subtracting the antisymmetric from the symmetric portion. ASTROS does not have the SUBCOM option.

All symmetric conditions use inertia relief to restrain the rigid body modes of the model:

X	- fore/aft
Z	- vertical
Rotation about Y	- pitch

3.5.5 Mechanical Properties and Allowables Development.

Material selection for fighter aircraft must be keyed to service conditions, most critically, temperature. For our study, cool areas (180°F) employ a nominal unidirectional composite material - IM7/PEEK (poly-ether-ether-ketone thermoplastic). Warm areas were assumed to be IM7/BMI (bismaleimide thermoset) unidirectional composite at 350°F. The mechanical properties and allowables of IM7/PEEK and IM7/BMI at 180°F and 350°F are roughly equivalent, which allowed us to use the same basic material modulus for the complete vehicle. This material was used to define equivalent materials for two nominal composite lay-ups. These layups are then used as single ply composite shell properties:

		APPLICATION
Basic material:	unidirectional	- wing skin general orthotropic layup with plies at 0/45/-45/90 degrees.
Equivalent:	all 45's	- side skins and wing substructure balanced +/-45's.
	quasi-isotropic	- fuselage top/bottom skins, frames, and bulkheads.

These values are based on current test data adjusted for projected improvements in fiber to matrix bonding. Improving the fiber/matrix interface properties enhances the translation of fiber to composite properties.

The power of ASTROS and this model is that material substitutes can be quickly performed and the model rerun to get an objective comparison. Therefore, only one composite material was included in the model. Further specialization of the material distribution, however, is eventually warranted. But, once a diverse mixture of materials is incorporated, the easy rerun flexibility is lost. Achieving a feasible design was felt to be more critical than a carefully tailored material assignment.

Nominally, locations with temperatures from 350 to 600°F in the aft engine bay area are not treated in the model as metallic, but are anticipated to be constructed primarily of elevated temperature aluminum and titanium. Locations with temperatures over 600°F are too localized to warrant study in

the preliminary phase, but titanium and Ti-aluminide are the prime candidate materials here.

A key modeling parameter for structural optimization is the non-optimum material density. The value chosen for the ASTOVL fighter was 1.5 times the true density. This quantity must account for the extra weight associated with splices, joints, fasteners, and anything else which is not modeled in detail. Little historical data is available to guide the analyst in this determination. Some studies at Northrop using REVWING on the F-18 wing, indicate a factor of 2.0 for the skins and spars, and 5.0 for the ribs. We chose the 1.5 value because we felt the REVWING results to be case specific and not applicable to this vehicle. This is, however, an area for active research.

Although the non-structural mass terms on element property cards are ignored for designed elements in ASTROS, this might be the proper mechanism to address the non-optimum density issue. A useful option would be to specify a function relating the non-structural mass to the element thickness/area. This allows variation in the effective non-optimum density factor. A higher ratio is anticipated for light gages than for heavy ones.

3.6 ANALYSIS DATA REQUIREMENTS - STATIC, DYNAMIC, AND AEROELASTIC MODELS

The static and dynamic structural models are the same. Finite element simulations modeled with NASTRAN or ASTROS are stiffness models. The stiffness of the overall structure derives from the assemblage of each element's stiffness. Graphic depiction of the model is the best way to assess the correlation with the real article. Local thicknesses and areas, being defined by ASTROS for virtually all structure, change with every iteration and are the primary result rather than input. In addition, when using inertia relief to react the external static loads, a good mass distribution is essential. Once the stiffness and mass models are complete, enough information is available to conduct dynamic analyses as well. The aerodynamic models as shown in **Figures 7 and 8** for steady aero, and **Figure 9** for unsteady aero are connected to the structure model with SPLINEs and ATTACHs.

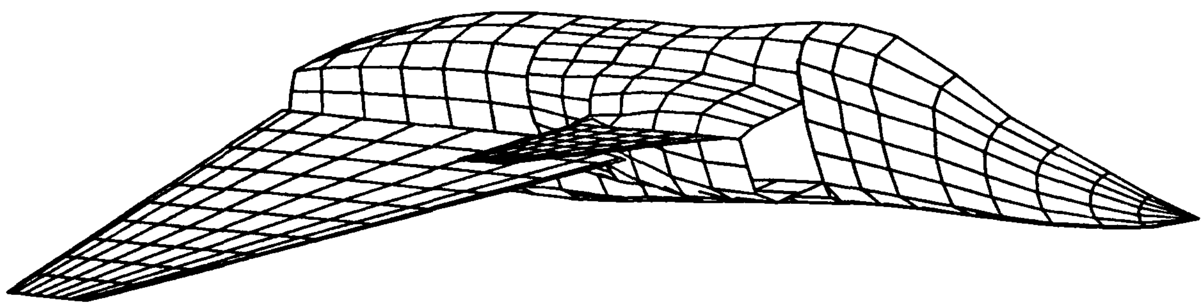


Figure 7. N382-20 ASTROS Steady Aerodynamics Model, Looking Aft and Inboard (RH Side)

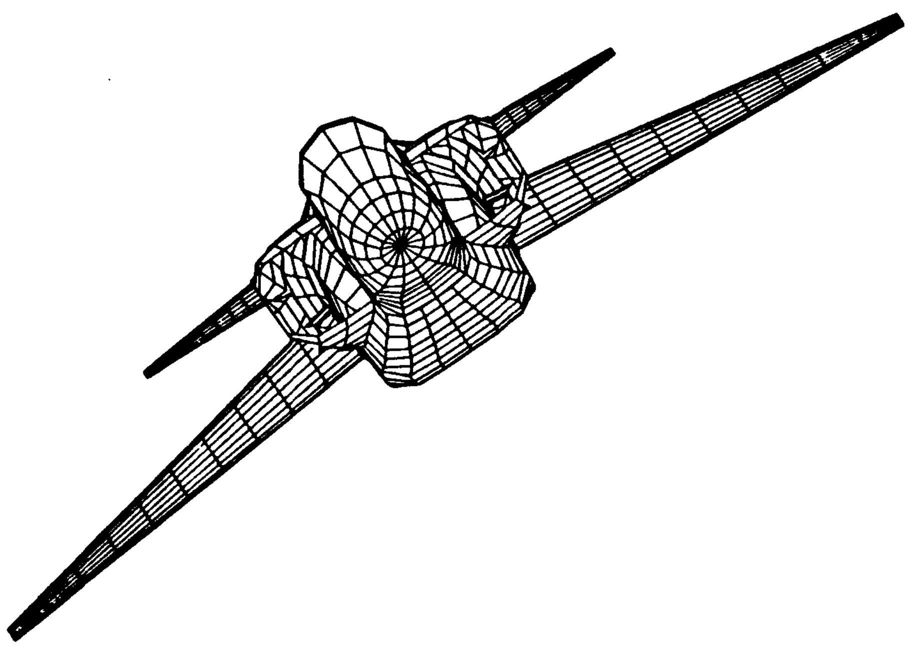


Figure 8. ASTROS Steady Aerodynamics Model, Looking Aft (Both Halves are Shown for Checkout Only)

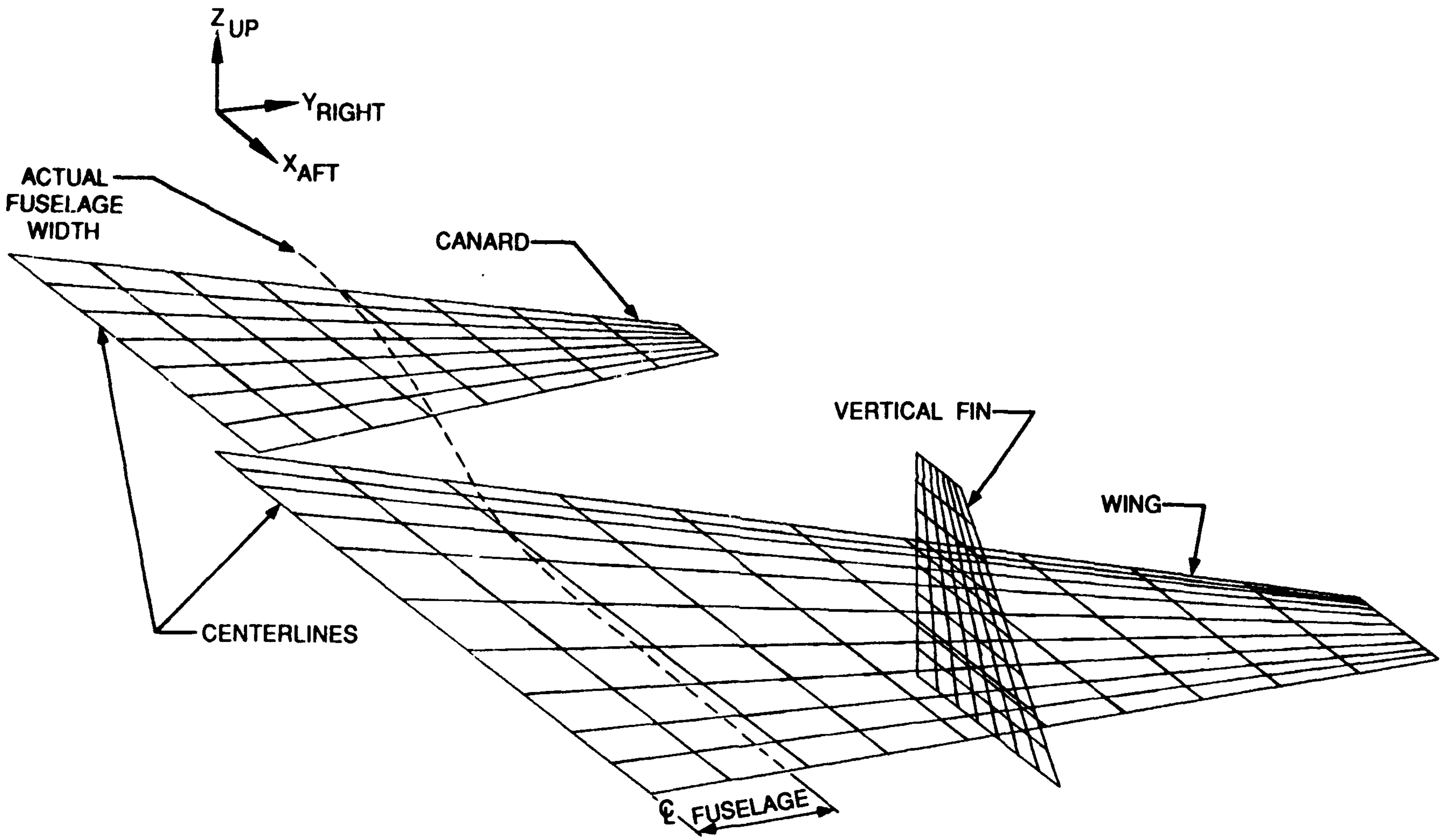


Figure 9. ASTROS Unsteady Aerodynamic Model

3.6.1 Static Model

Working from the stiffness model as the foundation, the mass contributions of structural and non-structural equipment must be accounted for. The mass model for the vehicle is derived from 2 types of sources:

1. Densities on the structural materials and the areas/thicknesses of the property cards. All the structure except for the vertical fin and canard is designed, so this weight changes for each iteration.

2. CONM2 elements which represent the non-structural mass. None of the non-structural mass is designed, so this is a fixed quantity during all iterations.

A copy of the complete input deck, including executive data, solution control data, and bulk data is shown in Appendix C.

The bulk data has extensive internal documentation through comment cards. The arrangement of the structural data is by structural segments. Prior to the grids and elements is a single section containing all the material and property cards.

Following the structural inputs comes the design model specifications. Included in the design section are the design variables and their shape functions, and the design constraints.

Next, are the aerodynamic model descriptions for steady and unsteady aeroelastic computations. Dynamic reduction and eigenvalue extraction data comes next with the flutter data last.

Multi-Point Constraints (MPC). MPCs are used to join the wing, aileron, fuselage, and pod segments. Recovery of the forces of MPC provides the interface forces from segment to segment (especially wing-to-fuselage lug loads).

Single-Point Constraints (SPC). Centerline symmetry in the basic coordinate system has directions 2, 4, and 6 fixed on the nodes lying in the plane of symmetry. The model is a right-half model as is required for the aerodynamic computations. The rotational degrees of freedom of all grids were restrained (SPC in 456) with a GRDSET card with a number of exceptions where bar elements with bending stiffness properties were necessary.

Numbering Scheme for GRIDs and Elements. Since this model is relatively small, a simple numbering scheme was adequate. Larger models often have GRID numbers 5 or 6 digits long, with the first 3 digits being the fuselage station number. This model would not have benefited from such an arrangement. Table 4 lists the grid and element numbering scheme.

The basic coordinate system for the aircraft as required for aerodynamic calculations has:

X	aft
Y	right
Z	up

Table 5 gives run time statistics for a typical ASTROS run.

Loads. The description of the loads incorporated in the final run can be determined from the Solution Control Data Packet in the input data file (Appendix C). Both Steady Aeroelastic (SAERO) and Static disciplines use inertia relief with SUPORT cards. Modes and Flutter disciplines work without SUPORTs for rigid body motion delineation, but Generalized Dynamic Reduction (GDR) permits no SUPORTs to work.

Landing loads are quasi-static equivalent of the actual transient dynamic condition. This assumption is necessary to allow optimization of the structure for these load conditions because ASTROS does not optimize for transient loads (i.e., analysis only).

TABLE 4. GRID AND ELEMENT NUMBERING SCHEME

GRID/ELEMENT NUMBERS	SECTION
1000-1999	WING
2000-2999	FORWARD FUSELAGE
3000-3999	MID FUSELAGE
4000-4999	AFT FUSELAGE
5000-5999	POD & VERTICAL

WING :

GRIDS AND ELEMENTS ARE NUMBERED FORWARD TO AFT IN STRIPS STARTING AT THE WING ROOT AND WORKING TO THE TIP.

LOWER SURFACE-

GRIDS	ODD NUMBERS FROM 1001-1159	
ELEMENTS	ODD NUMBERS FROM 1001-1135	

UPPER SURFACE-

GRIDS	EVEN NUMBERS FROM 1002-1160	(ADD 1 TO CORRESPONDING LOWER WING GRID)
ELEMENTS	EVEN NUMBERS FROM 1202-1336	(ADD 201 TO CORRESPONDING LOWER WING ELEMENT)

RIBS ELEMENTS-

1501-1508 RIB 1 (ROOT)
1511-1518 RIB 2
1521-1522 STUB RIB
1531-1537 RIB 3
1541-1546 RIB 4
1551-1555 RIB 5
1561-1564 RIB 6
1571-1574 RIB 7 (TIP)

1701-1702 MLG RIB

SPAR ELEMENTS-

1601-1607 LEADING EDGE SPAR (SWEPT)
1611-1613 1ST INTERMEDIATE
1621-1624 2ND INTERMEDIATE
1631-1635 3RD INTERMEDIATE
1641-1646 4TH INTERMEDIATE
1651-1657 5TH INTERMEDIATE
1661-1667 TRAILING EDGE SPAR (WITH GAP AT POD)

1674-1677 SPAR ON AILERON

FUSELAGE :

GRIDS ARE NUMBERED STARTING AT THE BOTTOM AND WORKING AROUND THE OUTSIDE OF THE BARREL TO THE TOP, THEN THE INSIDE STRUCTURE IS NUMBERED INBOARD TO OUTBOARD, FROM BOTTOM TO TOP. EACH STATION CUT IS COMPLETED THEN THE NUMBERING MOVES AFT TO THE NEXT FUSELAGE STATION.
ELEMENTS ARE NUMBERED SIMILAR TO THE GRIDS. ALL THE SKINS ARE DONE FIRST, THEN THE BULKHEADS AND FRAMES, THEN ANY FLOORS OR OTHER INTERNAL LONGITUDINAL STRUCTURE. LONGERONS ARE NUMBERED STARTING AT 501 WITHIN THE SEQUENCE FOR THE SEGMENT FROM FRONT TO BACK, THEN FROM BOTTOM TO TOP.

TABLE 4. GRID AND ELEMENT NUMBERING SCHEME (Continued)

FORWARD FUSELAGE :
GRIDS-
2001-2251

ELEMENTS-
2001-2176 OML SKINS
2201-2251 BHD 175
2232-2248 BHD 228
2261-2266 BHD 269
2271-2285 BHD 282
2301-2361 COCKPIT AND EQUIPMENT FLOOR, NOSE WHEEL WELL

2501-2511 LOWER LONGERON
2521-2531 UPPER LONGERON

2701-2891 STABILITY BARS

CENTER FUSELAGE :
GRIDS-
3001-3362

ELEMENTS-
3001-3112 OML SKINS
3121-3138 BHD 330
3141-3151 FRAME 360
3161-3188 BHD 390
3191-3210 FRAME 420
3221-3238 BHD 454
3251-3262 FRAME 475
3271-3283 FUEL TANK FLOOR
3301-3358 INLET OML SKIN
3361-3411 INLET FRAMES

3501-3506 LOWER LONGERON
3511-3516 UPPER LONGERON
3521-3526 DORSAL LONGERON
3551-3557 INLET UPPER LONGERON
3561-3567 INLET UPPER LONGERON

3801-3854 RALS DUCT TUNNEL
3901-3989 INLET IML SKIN

AFT FUSELAGE :
GRIDS-
4001-4176

ELEMENTS-
4001-4092 OML SKINS
4101-4114 BHD 495
4121-4132 FRAME 520
4141-4152 BHD 545
4161-4172 BHD 581
4181-4192 BHD 615
4201-4212 FRAME 648

TABLE 4. GRID AND ELEMENT NUMBERING SCHEME (Concluded)

4501-4505 LOWER LONGERON
4511-4515 UPPER LONGERON
4531-4534 WING LUG LOWER STIFFENER
4541-4544 WING LUG UPPER STIFFENER

<u>MLG/VERTICAL FIN POD:</u>

GRIDS-

5001-5150

ELEMENTS-

5001-5150 OML SKINS
5201-5206 BHD 545
5221-5228 BHD 581
5241-5246 BHD 615
5261-5266 BHD 633
5281-5286 BHD 655
5301-5306 BHD 680
5321-5326 BHD 695
5341-5346 BHD 733
5361-5366 BHD 751

5404, -ROD
5411, 5412, 5415, 5416, -BARS REPRESENT THE VERTICAL FIN
5421, 5426

5501-5508 BOTTOM STIFFENER
5511-5518 TOP STIFFENER
5521-5528 INBOARD STIFFENER
5531-5538 OUTBOARD STIFFENER

TABLE 5. TYPICAL ASTOVL MODEL RUN TIME STATISTICS

TYPICAL RUN-TIME MODEL STATISTICS (RUN 02H):

GRIDS	870
SPCS	258 GRIDS
MPCS	309 GRIDS

DEGREES OF FREEDOM

ORIGINAL	5220
SPC'D	2557
MPC'D	147 DEPENDENT
SUPORT'D	2
ANALYSIS	2514

GLOBAL DESIGN VARIABLES

DESELMS	3
DESVARS	
SHAPE FUNCTIONS	170
TOTAL	173

ELEMENTS	NUMBER	NUMBER OF DESIGNED (LOCAL DESIGN VARIABLES)
TRMEMS	8	32 = 8 X 4 PLIES/ELEMENT
QDMEM1S	76	304 = 76 X 4 PLIES/ELEMENT
RODS	109	103
CONM2S	166	3
BARS	106	0
QUAD4S	867	863
TRIA3S	66	58
TOTAL	1398	1363

STEADY AERO PANELS

WING	100
CANARD	56
FUSELAGE	222
TOTAL	378

UNSTEADY AERO PANELS

WING	100
CANARD	56
FUSELAGE	56
TOTAL	212

Non-Linear Analysis. ASTROS does not analyze or optimize for buckling or non-linear analysis in the current and anticipated versions. While general buckling instability is typically not a problem for fighter aircraft, local panel buckling is, and for a major fraction of the structure. This is a critical omission by ASTROS which must be addressed by the analyst through separate means after the optimization/analysis and should be incorporated into ASTROS as soon as possible.

Design Model Specification. Intuitively every element would be designed, but this occasionally results in large thickness variations from element to element. Also, with so many design variables (1400 local design variables in this model), mathematical programming techniques become intractable. To overcome these problems, design variable linking is applied to reduce the number of global design variables and to rationalize the design for manufacturing. Shape functions were used to smoothly vary element thicknesses (ply drop-offs) over sizable regions of structure. Each region can have as many shape functions as desired. By combining constant, linear, and quadratic shapes along the span and chord directions of the wing, complex polynomial thickness distributions were created for each wing skin "ply." Each designed ply actually represents the total thickness at a particular ply orientation angle. Similar polynomial functions along the station direction apply to the fuselage elements.

Table 6 lists the complete set of design variable shape functions.

3.6.2 Dynamic Analysis Model

There is no difference between the static and dynamic structural models.

Normal Modes. Generalized Dynamic Reduction (GDR), occasionally known as subspace iteration, was used to calculate 20 to 30 approximate mode shapes. Then Givens factorization was applied to the approximate mode shapes to provide all 20 to 30 frequencies and as many mode shapes as requested. Typically 12 to 15 mode shapes are obtained.

TABLE 6. ASTROS DESIGN VARIABLE SHAPE FUNCTIONS

NUMBER OF DESVARS	STRUCTURE
74	WING
24	FORWARD FUSELAGE
36	MID FUSELAGE
31	AFT FUSELAGE
8	POD
173 TOTAL	

WING DESIGN VARIABLES		
DESELMS	ELEMENT TYPE	DESCRIPTION
3	CONM2S	BALANCE MASSES ON THE LEADING EDGE

SHAPE FUNCTIONS	STRUCTURE	SHAPE DESCRIPTION
20	LOWER SKINS	CONSTANT + LINEAR SPANWISE + QUADRATIC SPANWISE + LINEAR CHORDWISE + QUADRATIC CHORDWISE IN EACH OF 4 PLY DIRECTIONS 0°/+45°/-45°/90° (0° = SPANWISE, 90° = CHORDWISE) MINIMUM GAGE .010 EACH PLY DIR.
20	UPPER SKINS	CONSTANT + LINEAR SPANWISE + QUADRATIC SPANWISE + LINEAR CHORDWISE + QUADRATIC CHORDWISE IN EACH OF 4 PLY DIRECTIONS MINIMUM GAGE .010 EACH PLY DIR.
3	RIBS	CONSTANT RIBS 1 & 2 RIBS 3 & 4 RIBS 5, 6, & 7 MIMIMUM GAGE .040
12	SPARS	CONSTANT + LINEAR LENGTHWISE (2 DESVARS EACH SPAR) LEADING EDGE SPAR SPARS 1 & 2 SPAR 3 SPAR 4 SPAR 5 SPAR 6 MINIMUM GAGE .040
8	LEADING EDGE	CONSTANT + LINEAR SPANWISE IN EACH OF 4 PLY DIRECTIONS MINIMUM GAGE .010 EACH PLY DIR.
8	AILERON	CONSTANT + LINEAR SPANWISE IN EACH OF 4 PLY DIRECTIONS MINIMUM GAGE .010 EACH PLY DIR.
74 TOTAL WING		

TABLE 6. ASTROS DESIGN VARIABLE SHAPE FUNCTIONS (Continued)

FUSELAGE DESIGN VARIABLES		
SHAPE FUNCTIONS	FORWARD FUSELAGE STRUCTURE	SHAPE DESCRIPTION
		STATION WISE
3	BOTTOM SKIN	CONSTANT + LINEAR + QUADRATIC
2	TOP SKIN (FWD OF COCKPIT)	CONSTANT + LINEAR
2	TOP SKIN (AFT OF COCKPIT)	CONSTANT + LINEAR
5	BHDS & FRAMES	CONSTANT
	STATION	
	175	
	195/201	
	228	
	269	
	282	
3	COCKPIT FLOOR	CONSTANT + LINEAR + QUADRATIC
	NOSE WHEEL WELL	
		ALL : QUASI-ISOTROPIC COMPOSITE MINIMUM GAGE .040
		STATION WISE
3	SIDE SKINS	CONSTANT + LINEAR + QUADRATIC
		ALL 45° FABRIC MINIMUM GAGE .040
		STATION WISE
3	UPPER LONGERON	CONSTANT + LINEAR + QUADRATIC
3	LOWER LONGERON	CONSTANT + LINEAR + QUADRATIC
		ISOTROPIC MATERIAL WITH NOMINAL PROPERTIES FOR 60/30/10 COMPOSITE LAYUP MINIMUM AREA .12
24 TOTAL FORWARD FUSELAGE		

FUSELAGE DESIGN VARIABLES		
SHAPE FUNCTIONS	MIDDLE FUSELAGE STRUCTURE	SHAPE DESCRIPTION
		STATION WISE
3	BOTTOM SKIN	CONSTANT + LINEAR + QUADRATIC
3	TOP SKIN	CONSTANT + LINEAR + QUADRATIC
6	BHDS & FRAMES	CONSTANT
	STATION	
	330	
	360	
	390	
	420	
	454	
	475	
2	FUEL TANK FLOOR	CONSTANT + LINEAR
3	INLET FRAMES	CONSTANT
2	INLET OUTER SKIN	CONSTANT + LINEAR
		ALL : QUASI-ISOTROPIC COMPOSITE MINIMUM GAGE .040
		STATION WISE
3	SIDE SKIN	CONSTANT + LINEAR + QUADRATIC
2	RALS DUCT TUNNEL	CONSTANT + LINEAR
2	INLET INNER SKIN	CONSTANT + LINEAR
		ALL 45° FABRIC MINIMUM GAGE .040
		STATION WISE
6	LONGERONS (3)	CONSTANT + LINEAR
	UPPER	
	LOWER	
	DORSAL	
4	LONGERONS (2)	CONSTANT + LINEAR
	INLET	
	UPPER	
	LOWER	
		ISOTROPIC MATERIAL WITH NOMINAL PROPERTIES FOR 60/30/10 COMPOSITE LAYUP MINIMUM AREA .12
36 TOTAL MIDDLE FUSELAGE		

TABLE 6. ASTROS DESIGN VARIABLE SHAPE FUNCTIONS (Continued)

FUSELAGE DESIGN VARIABLES		
SHAPE FUNCTIONS	AFT FUSELAGE STRUCTURE	SHAPE DESCRIPTION
		STATION WISE
3	BOTTOM SKIN	CONSTANT + LINEAR + QUADRATIC
3	TOP SKIN	CONSTANT + LINEAR + QUADRATIC
2	FRAMES STATION 520 644	CONSTANT
		VERTICALLY
3	BHD 495	CONSTANT + LINEAR + QUADRATIC
3	BHD 545	CONSTANT + LINEAR + QUADRATIC
3	BHD 581	CONSTANT + LINEAR + QUADRATIC
3	BHD 615	CONSTANT + LINEAR + QUADRATIC
		ALL : QUASI-ISOTROPIC COMPOSITE MINIMUM GAGE .040
		STATION WISE
3	SIDE SKIN	CONSTANT + LINEAR + QUADRATIC
		ALL 45 DEGREES FABRIC MINIMUM GAGE .040
		STATION WISE
4	LONGERONS (2) UPPER LOWER	CONSTANT + LINEAR
4	STIFFENERS (2) WING LUG UPPER LOWER	CONSTANT + LINEAR
		ISOTROPIC MATERIAL WITH NOMINAL PROPERTIES FOR 60/30/10 COMPOSITE LAYUP MINIMUM AREA .12
31 TOTAL AFT FUSELAGE		

TABLE 6. ASTROS DESIGN VARIABLE SHAPE FUNCTIONS (Concluded)

DESIGN VARIABLE SHAPE FUNCTIONS		
SHAPE FUNCTIONS	VERTICAL FIN & MLG POD STRUCTURE	SHAPE DESCRIPTION
4	SKIN	STATION WISE CONSTANT + LINEAR + QUADRATIC VERTICALLY + LINEAR
4	BHDS STATION 545 & 581 615 & 633 655, 680, & 695 735 & 751	CONSTANT ALL COMPOSITE TOP/BOTTOM : QUASI-ISOTROPIC SIDES : ALL 45° FABRIC MINIMUM GAGE .040
	OR	
2	SKIN	STATION WISE CONSTANT + LINEAR
4	BHDS STATION 545 & 581 615 & 633 655, 680, & 695 735 & 751	CONSTANT ALL COMPOSITE TOP/BOTTOM SKINS AND BHDS : QUASI-ISOTROPIC SIDE SKINS : ALL 45 DEGREE FABRIC MINIMUM GAGE .040
1	STIFFENERS (2) UPPER LOWER	CONSTANT
1	STIFFENERS (2) SIDE INBOARD OUTBOARD	CONSTANT ISOTROPIC MATERIAL WITH NOMINAL PROPERTIES FOR 60/30/10 COMPOSITE LAYUP MINIMUM AREA .12
8 TOTAL POD		

The structure mass and stiffness model is as discussed in the static analysis, Subsection 3.6.1, and shown in the figures.

Complex eigenvalue, frequency response, and transient response analysis were not considered for preliminary analysis. The landing impact load cases are transient dynamic events. ASTROS, however, does not optimize for transient load cases so approximate static equivalents were used to account for these load cases which typically generate the maximum up-bending moments on the fuselage.

Random Response Analysis. Acoustic loads near the engine exhaust nozzle were examined parametrically, but were not considered in the overall finite element model.

3.6.3 Aeroelastic Analysis Model

Stiffness and mass matrices were defined in Subsection 3.6.1. The steady aerodynamic model is shown in **Figures 7 and 8**. ASTROS uses Woodwards USSAERO code (Reference 1). USSAERO uses panel methods for steady aerodynamics. The vertical tail and pod were not considered critical for the symmetric flight loads analyzed because the vertical component of lift due to angle-of-attack is very small compared to the wing, body, and canard. Yaw force on the vertical induces large lateral bending and torsion on the pod. But the flutter tendencies of the vertical fin/pod combination induces enough strength and stiffness in this area that flutter is more critical.

The canard and wing are modeled with lifting surface elements which include thickness and camber effect. The fuselage is composed of body type aero panels.

Connection of Aerodynamics to Structure. Three SPLINE1s connect the aero-to-wing structure lower skin nodes: (1) one inboard of the aileron; (2) one forward of the aileron; and (3) one on the aileron. SPLINE1s are surface splines, suitable for interpolating loads between two coincident flat surfaces such as wings, but are not suitable for highly curved surfaces as found on fuselages. One ATTACH card connects the canard aero model to the canard spindle tip GRID.

Each macro element on the fuselage connects via ATTACHs to a single GRID point. Because the transfer of load includes moments, these points must have rotational bending stiffness. Since designed QUADs/TRIAs do not have bending stiffness, only grid points with BARs attached were suitable. The scarcity of bending elements in the structure dictated the choice for ATTACHing aero to structure. Many stability BARs were available in the forward fuselage; the center fuselage only has the canard spindle BARs; and the aft fuselage has the engine mount BARs.

Unsteady Aerodynamic Model (Flutter). ASTROS Method of Unsteady Aerodynamics/flutter for supersonic speeds uses the constant pressure method (CPM, Reference 6) for aerodynamics and the P-K modal flutter approach similar to NASTRAN and FASTOP (References 3 and 5). Where,

P - complex eigenvalue

K - reduced frequency - wc/2v

- w - circular natural frequency of vibration
- c - mean aerodynamic chord
- v - vehicle forward velocity

The ZANLYN routine is employed to solve the coupled flutter equations.

Supersonic body elements are not available in unsteady aerodynamics, so the canard and wing lifting surfaces are extended to the vehicle centerline (maintaining leading and trailing edge sweep angles) to approximate the effect of the body in the vicinity of the wing and canard.

Note, the vertical fin was not included in early versions of the model since it was not considered critical for preliminary design where only symmetric conditions are included. Subsequent results showed large pod lateral dynamic motion and flutter tendencies. Thus, we added a vertical fin to the unsteady aero, hoping to get some aerodynamic damping.

The same wing SPLINEs and canard ATTACH were used as applied in steady aero. The vertical fin unsteady aero model was ATTACH'd to its four structural corner GRIDs.

Three rigid body modes were omitted from the flutter analysis in the axial, plunge, and pitch directions because the optimizer had no mechanism to correct any violation of the constraints associated with them.

3.7 RESULTS AND RECOMMENDATIONS

Deflections. SAERO and STATICs results indicated that deflections were within reasonable limits; so no explicit deflection constraints were needed or applied. Comparisons were made between equivalent ASTROS and NASTRAN runs for an all metal airframe. The ASTROS values for deflections and element loads were typically within 2 to 3 percent.

Figures 10 through 13 compare deformed and undeformed shapes for the Mach 1.2 9g symmetric pull-up load case. **Tables 7 and 8** list deflection and acceleration results for selected locations on the fuselage and wing.

Element Forces. Printed tables of the element forces are so large that we leave it up to the recipient of the model to exercise it to generate the forces as desired. Also, no graphical output is available with the current version of ASTROS Detailed loads in key areas are discussed in a separate report for the Ultralightweight Structures program dealing with the structural trade studies.

Wing skin loads of the ASTOVL fighter are somewhat low compared to most fighter aircraft. Typical fighter wings usually have 6000-10,000 lb/in spanwise running load. The maximum wing skin spanwise loads for N382-20 under a 9g symmetric pull-up case are approximately 5000 lb/in (ultimate) with a local concentration of 5700 lb/in at the main landing gear pod attach area. This appears to be the result of a relatively large area delta wing, inertia relief from the wing internal fuel and mass of the MLG/vertical fin pod, and aeroelastic redistribution of the lift to inboard wing region. The redistribution does not change the total wing shear, but it does reduce the effective

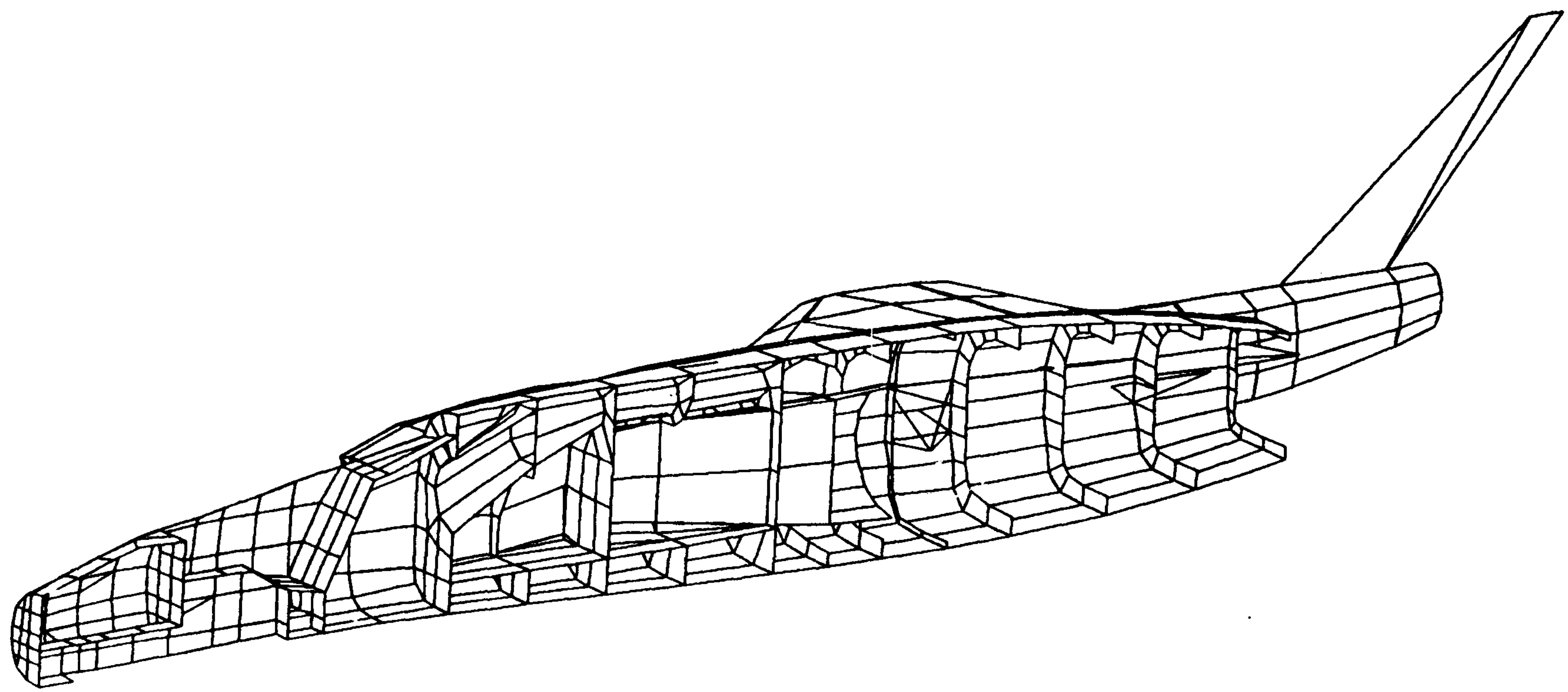


Figure 10. Undeformed ASTROS Model, Looking Outboard

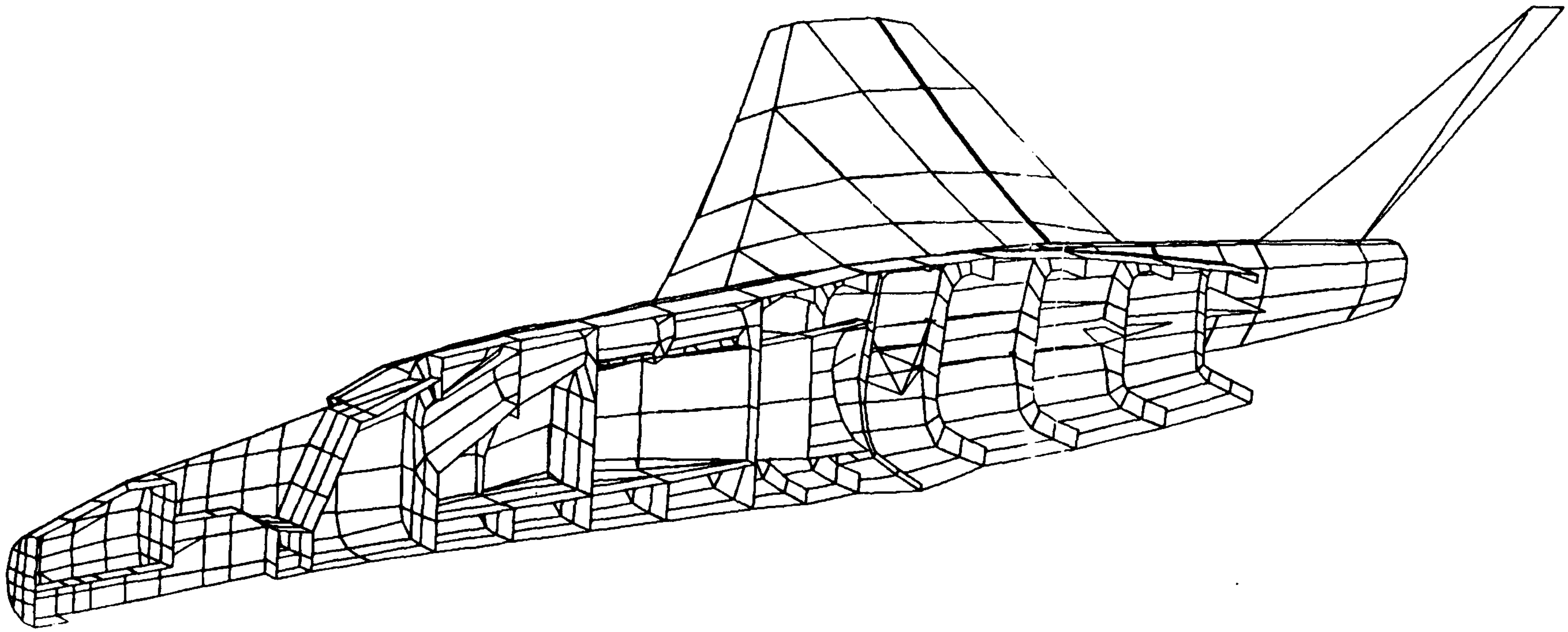


Figure 11. ASTROS Model Deformations for Mach 1.2 9g Symmetric Pull-Up, Looking Outboard

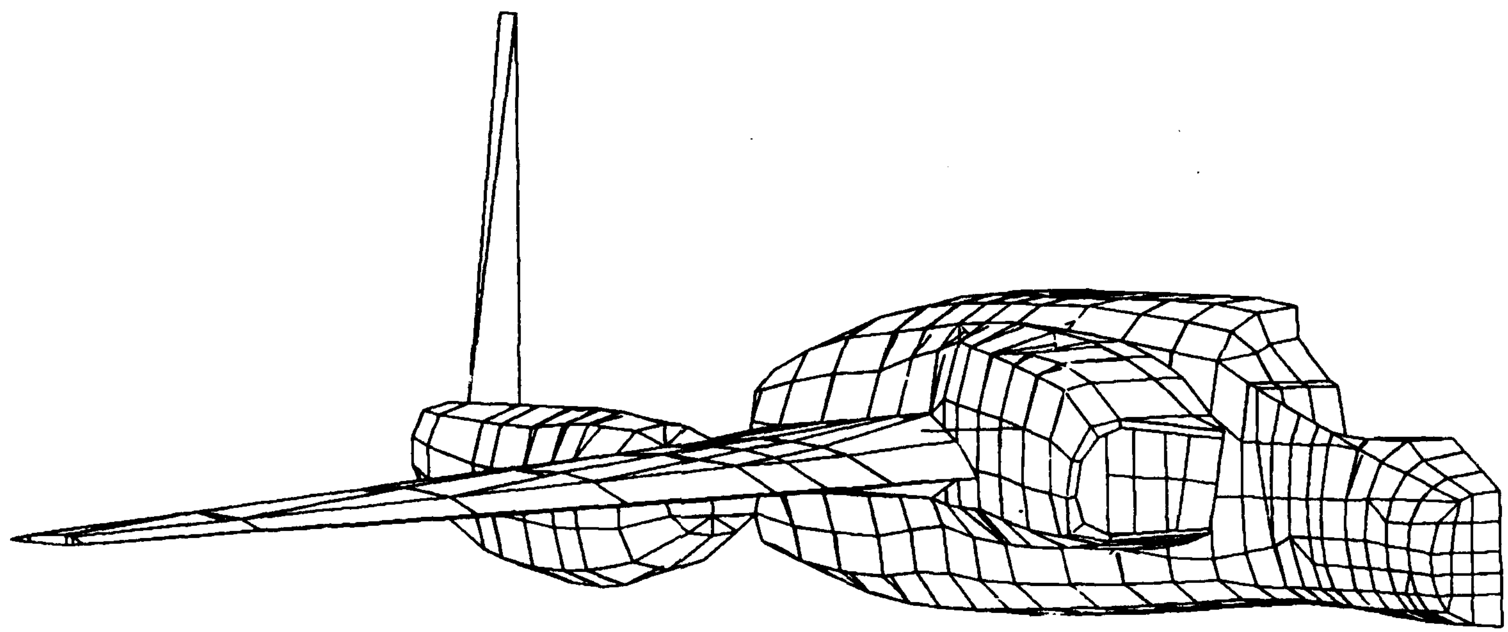


Figure 12. Undeformed ASTROS Model, Looking Aft

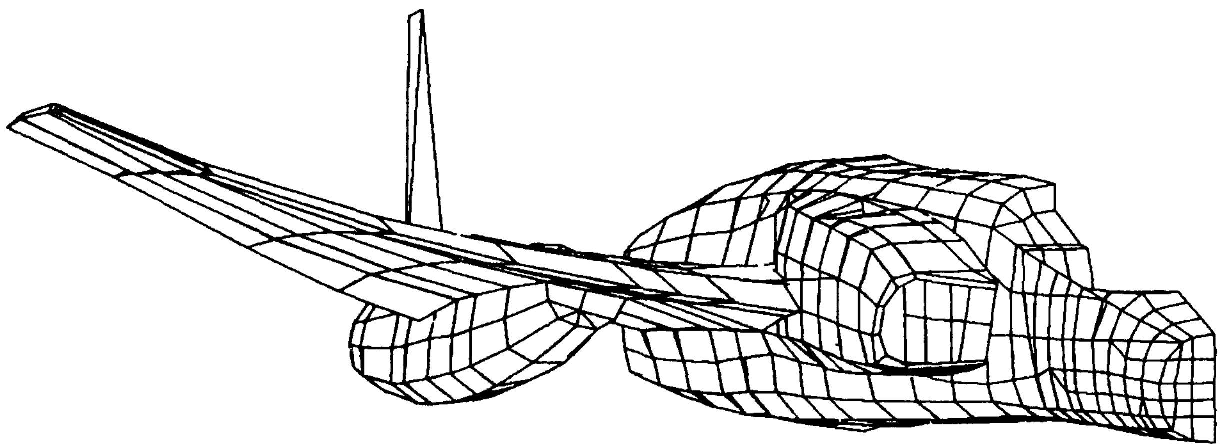


Figure 13. ASTROS Model Deformations for Mach 1.2 9g Symmetric Pull-Up, Looking Aft

TABLE 7. ASTROS STATIC DEFLECTION RESULT SUMMARY

VERTICAL (Z) DEFLECTIONS (IN)							
	FUSELAGE			WING TIP		POD	MLG OR NLG
LOAD CONDITION	FORWARD	MID	AFT	FORWARD	AFT	AFT END	NODE
NLG IMPACT	3.212	0.0	.229	.579	.932	1.126	2.964 NLG
MLG IMPACT	-1.478	0.0	-.023	.550	-.575	-2.443	1.019 MLG
13.5GS SAERO	-1.235	.211	-1.058	16.663	16.120	-3.885	-
1.0GS SAERO	-.070	-.104	-.065	.739	1.454	.041	-
-4.5GS SAERO	.443	-.243	.372	-6.268	-4.999	1.769	-

TABLE 8. ASTROS STATIC ACCELERATION RESULT SUMMARY

VERTICAL (Z) ACCELERATIONS (IN/SEC^2)		
	FUSELAGE	
LOAD CONDITION	FORWARD	AFT
NLG IMPACT	3586.	-1094.
MLG IMPACT	-1240.	4385.
13.5GS SAERO	5211.	5211.
1.0GS SAERO	386.	386.
-4.5GS SAERO	-1737.	-1737.

moment arm. The wing root bending moment is thereby reduced and hence the skin spanwise running loads are lower. In fact, at one iteration during the optimization process, the loads were virtually constant for much of the wing skins.

Spar loads change signs in the root bay due to shear loads carried by the vertical component of the in-plane skin load. The leading edge spar shear loads increase going outboard. Because the intermediate spars terminate on the swept leading edge spar, each outboard portion of the remaining spars must carry a larger percentage of the shear. In this case, the leading edge spar effects the redistribution of load to each spar terminating on it.

Fuselage loads follow the same trends as other fighter aircraft; primary fuselage vertical bending moment and shear load increase as one approaches the wing side-ties from forward and aft ends. The shear load is carried in the side skins and the moment is carried in the longerons and top/ bottom skins.

Frequencies. For the mid-plane symmetric boundary conditions there are 10 modes (**Table 9**) below 20Hz including the 3 rigid body modes (02J run, see Appendix A for description of run summaries).

The FS 520 frame flex mode (FR520) was due to excessive flexibility as the result of inadequate frame depth. No interaction with the aerodynamics occurs due to a single frame flexing, so omitting this mode from the flutter optimization causes no loss of accuracy. Subsequent flutter analysis following optimization proved that there was no coupling of mode 7 with the other modes.

Flutter. Mach 1.5 at 15000 ft was assumed for the flutter calculations. The maximum speed of the N382-20 ASTOVL is Mach 1.5 which crosses the 750 KNOT equivalent never exceed airspeed at an altitude of approximately 15000 ft.

The analysis and optimization for flutter point out the difficulty of dynamically stabilizing a wing with a large mass at the trailing edge. Typical flutter fixes use mass balance at the leading edge to best effect.

TABLE 9. FUNDAMENTAL FREQUENCE AND MODE SHAPES (02J RUN)

Mode	Frequency(Hz)	Mode Description
1	0	Fore/aft rigid body
2	0	Pitch rigid body
3	0	Plunge rigid body
4	7.958	First fuselage bending
5	8.645	First wing bending
6	8.834	First pod/vertical lateral bending
7	10.981	Frame 520 flex (spurious mode - omitted from flutter calculations)
8	14.495	Second fuselage bending
9	16.444	First wing twist, aileron deflection, pod roll
10	18.657	Pod roll + lateral bending, wing twist

The heavy pods with the aftward offset make the N382-20 configuration flutter prone. First mode flutter was found to be a problem at all velocities requested in the P-K flutter analysis (12000 in/sec to 19027 in/sec, 19027 in/sec = Mach 1.5).

The damping ratio at the velocity corresponding to Mach 1.5 at 15000 ft elevation was over three percent (02J). In the optimization, the flutter damping ratio was constrained to 0 percent or less. The optimizer was unable to eliminate this infeasibility. The flutter constraint sensitivity subroutine in ASTROS may have a defect which prevented the optimizer from finding a feasible direction from among the design variables for flutter correction.

Design Model Results. Element thicknesses and areas are the final product of the optimization process. For the N382-20 ASTOVL, the complete structure model for the fuselage, wing, and pod are eligible for redesign. Forward fuselage side skin thicknesses are clearly higher than experience indicates. The cause of this is the method of transferring loads from the

aerodynamic model to the structure model. Only a handful of GRIDs are directly loaded by the ATTACHs used to connect the two models. Large load spikes on these GRIDs overstress the adjacent skin elements and the optimizer increases the thickness to 0.187 to 0.337 in. to maintain a positive margin of safety. Preliminary model checkout runs which used rigid wing airloads but no body airloads demonstrated thicknesses on the order of 0.060 in. which is realistic. Figures 14 and 15 and Appendix E show ASTROS thickness results for selected elements throughout the vehicle. Thicknesses for the elements not listed can be interpolated from these numbers.

The beam spline, SPLINE2 in NASTRAN, provides a better means to transform loads from the aero panels to the structure. SPLINE2s are not currently available in ASTROS.

Satisfaction of Design Criteria. The primary design criteria satisfied with ASTROS simultaneous multidisciplinary optimization are strength, stiffness, and flutter. The stiffness requirement is satisfied by the other conditions without additional weight or displacement constraints. Stress/strain constraints are met by specifying a material stress/strain allowable on the material cards and constraining the material explicitly during optimization for the STATIC and SAERO disciplines. Every element referencing a material so constrained will have margins of safety calculated and reconciled, even if that element is not designed. Flutter is constrained by detailing the maximum allowed flutter damping as a function velocity.

The optimizer routine within ASTROS adjusts the element thicknesses and areas to satisfy all the constraints and concurrently minimizes the weight. The linearized automatic resizing is then checked with another analysis using the design values. Convergence occurs when all the constraints are within limits and the weight cannot be reduced further.

The optimizer will exploit all options the user permits. Omission of any constraint which is critical will allow the optimizer free reign to give unacceptable designs. Therefore inclusion of all constraints is recommended. Some constraints may be accommodated by careful selection of minimum gage values, but this assumes the best design is known ahead of time.

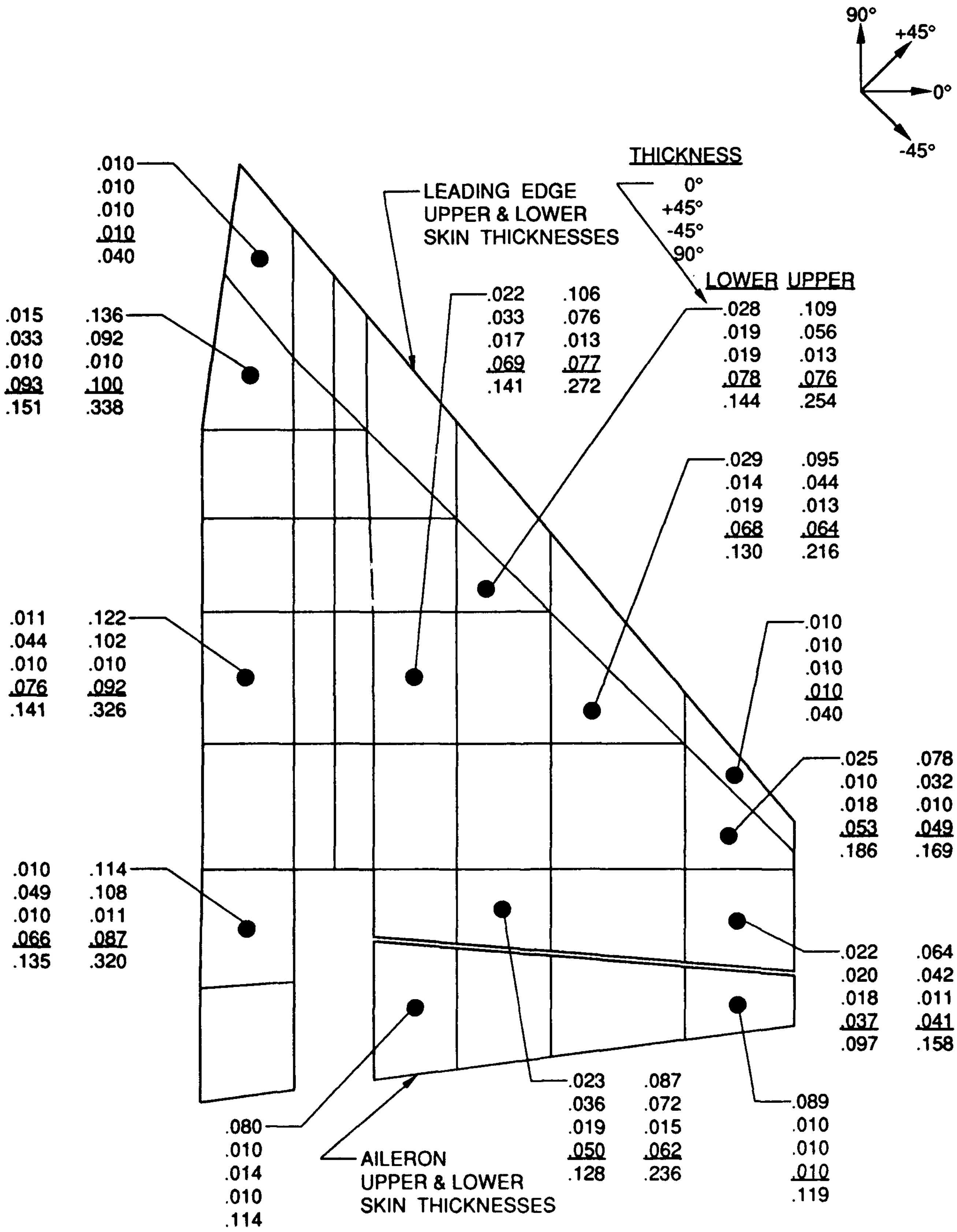


Figure 14. ASTROS Wing Skin Thickness Results

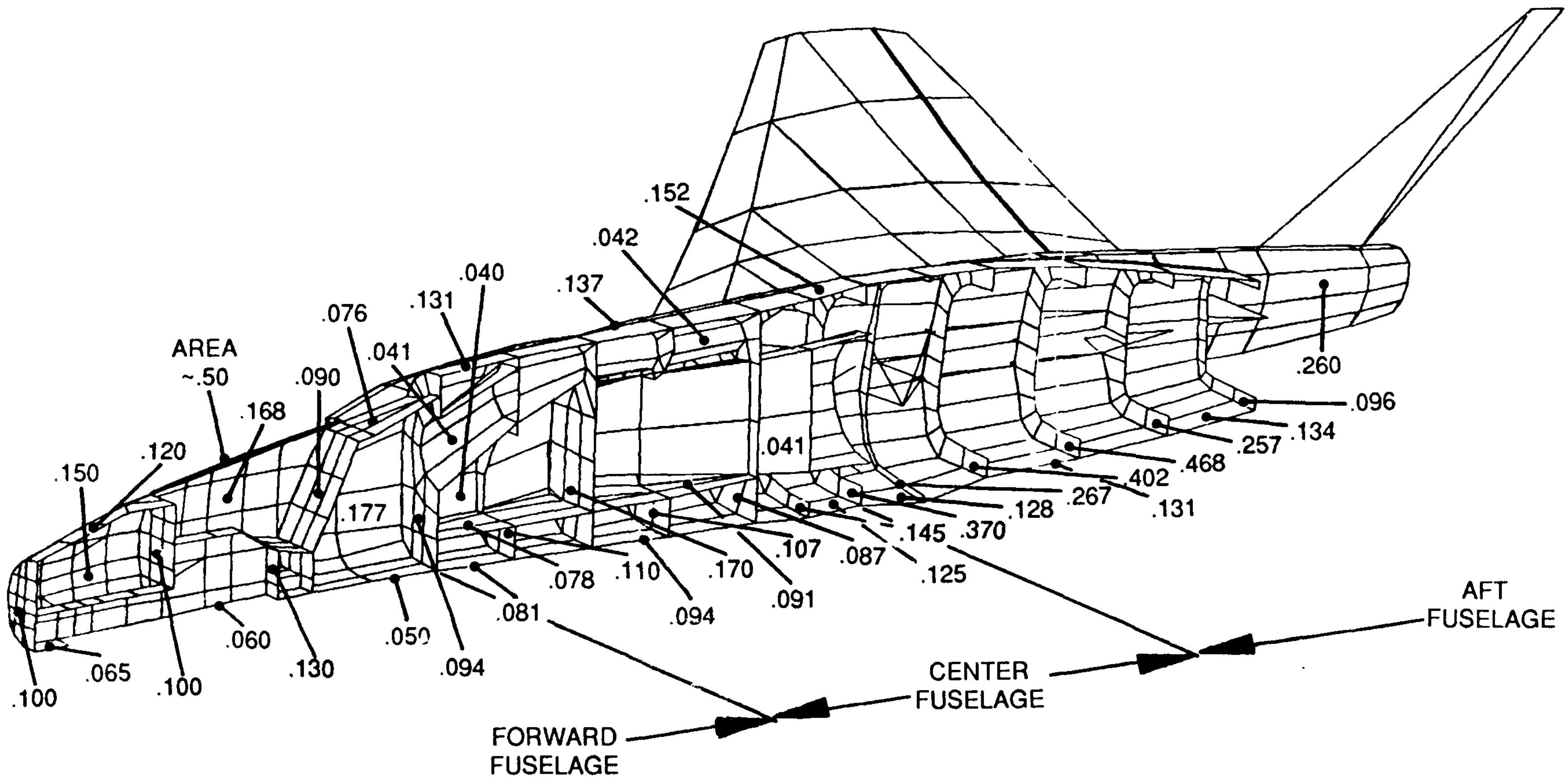


Figure 15. ASTROS Fuselage Structure Thickness Results

One of the benefits of automated design tools is to arrive at a non-intuitive solution which weighs less than the "obvious" one. Limiting the design with artificial minimum gage settings denies the optimizer the opportunity to find such an answer. Unfortunately for aircraft structures, local buckling is a primary design driver that ASTROS does not currently incorporate; the resulting thin gage skin solution that ASTROS provides will violate the buckling requirements. Nor does ASTROS handle postbuckling type analysis as this is a non-linear problem for which it was never intended, even though postbuckled designs may be lighter.

Recommendations for Further Studies for ASTOVL Model:

1. Loads: Add new load conditions

   A. Subsonic Flutter

   B. Antisymmetric Flight and Flutter

   C. Asymmetric Flight

   D. Cockpit Pressure

   E. Fuel Pressure

   F. Thermal effects

   G. SAERO loads on Pod and Vertical Fin

2. Structure: Add new structure

   A. Detailed Vertical Fin

   B. Cockpit Frames (plate elements)

   C. Canopy

   D. Bulkhead Cap elements

   E. Spar and Rib Cap elements

   F. Run the alternate wing internal configuration which was constructed with spars on percent chords. This wing, known as WING1, has not yet been merged with the fuselage model. We were seeking a feasible solution from the spars

perpendicular to the centerline wing, WING2, first. Merging this wing with the rest of the structure will require new MPCs at the wing lugs and pod interface, and new shape function design variable definitions. The structure model for WING1 will be included in the data file deliverables.

3. Materials/Properties Zoned

   A. Allowables vs temperature

   B. Varying density scale up factors for varying structure segments

4. Addition of a control system to the flutter analysis and optimization.

5. Design Model: Add DESVARs and Constrained elements

   A. Cockpit Frames

   B. Bulkhead Caps

   C. Spar and Rib Caps - tied to existing web DESVARs

   D. SAERO roll rate constraint to meet performance specifications

   E. Modifications to add more plies to the fuselage can be made easily to test the sensitivity of the quasi-isotropic top/bottom skins and the balanced 45 degree side skins

6. Delete DESVARS (frees up design variables for other areas) - In wing skins:

   A. By linking the upper and lower skins together

   B. Calling out balanced +45/-45 degree layup

   C. Any shape function design variable which has a negligible influence on the final thickness

ASTROS Modeling Guidelines:

1. Maximum number of global design variables - ~200

2. Maximum retained constraints - ~100 + Minimum Gage Constraints (specify the value of NRFAC = 100/NDV, in the solution control packet, where NDV = number of design variables)

3. Include all constraints. The optimizer will exploit all options the user permits. Omission of any constraints which are important will give the optimizer free reign to violate them.

4. DCONTHK at least one element for each shape associated with that group of elements.

5. The non-optimum material density value chosen must account for the extra weight associated with splices, joints, fasteners, and anything else which is not modeled in detail. Little historical data is available but a rule of thumb is to use a larger factor for coarse models.

6. Use of scaled-up density is not recommended to account for buckling. Studies at Northrop have shown that for a highly loaded composite panel which is buckling critical, changing the allowable strain from 6000 micro strain to 2000 micro strain caused no significant change in thickness and weight. Buckling is a function of the thickness cubed; other approximations to it, such as artificially reducing the strain allowable, will not suffice.

7. Different internal structure arrangements can be modeled for the same overall configuration to get unbiased comparisons of optimum designs

8. Different materials can be substituted for comparison

ASTROS Enhancement Recommendations

1. Graphical pre- and post-processors - particularly for the design data

2. General and panel buckling constraints, both analysis and optimization

3. Local crippling constraints, both analysis and optimization

4. Aerodynamic force output including aeroelastic correction

5. Inertial force output

6. PBAR section property by lengths and widths of stiffener legs, radius and wall thickness of round sections, etc.

7. Model debug and checkout tools:

   A. Grid Point Weight Generator

   B. AUTOSPC

   C. GRID number resequencing for bandwidth minimization

   D. NASTRAN epsilon and strain energy checks

8. SPC and MPC forces

9. Grid Point Force Balance

10. NASTRAN type PLOAD card inputs for pressure application

11. Some scalar measure of change in the design other than weight. Perhaps a vector norm which accounts for the absolute value magnitude change for each of the design variables.

12. SPCD type cards for subcase selectable forced displacements

13. Rigid elements comparable to NASTRAN's RBAR, RBE1-3, RROD, RSPLINE, RTRPLT

14. Improved three dimensional elements

15. Automatic ROD creation with SHEAR elements

16. Method to generate asymmetric internal loads for symmetric models (similar to SUBCOMs in NASTRAN)

17. Aeroelastic calculations about the center of gravity

18. Generic constraint - user input equations

19. New design constraints on the aeroelastic behavior:

   A. Maximum/minimum for angle-of-attack

   B. Control surface deflections

   C. Instantaneous roll rate

   D. Steady state roll rate

   E. Pitch rate

   F. All flexible stability derivatives

   G. All flexible/rigid stability derivative ratios

Enhancements Added and Errors Corrected in ASTROS.

1. Incorrect element results for all QUAD4s that were stress or strain constrained; due to internal reordering of GRID point coordinates.

2. Incorrect calculation of MPC transformation matrices in the presence of multiple MPCs chained together.

3. Incorrect spline transformations when using multiple splines in either steady or unsteady aerodynamics models.

4. Incorrect interpretation of the material orientation angle on QUAD4s and TRIA3s during results calculations.

5. Error in decomposing real, asymmetric matrices - as found in steady aeroelastic analysis - which failed with a false insufficient memory message.

6. Incorrect out of core handling of flutter sensitivity values for large numbers of sensitivities.

7. Element sorting error when only one element of a single type occurs in a ELEMLIST.

8. Incorrect QUAD4 stress output coordinate system when PCOMPs and/or material coordinate system is requested. Values were being computed and printed in the local material system for each ply rather than the element system as documented. Summing each ply's contribution to the element force gave erroneous answers. (TRIA3s)

9. Suppressed printing of zero load values when load print is requested.

10. Suppressed printing of zero load values when SPC force print is requested.

11. Excessively long steady aeroelastic computation times were reduced through a new formulation of the equations in the MAPOL sequence.

12. Element force print was modified for designed composite plate elements to give the forces as the sum of all plies rather than ply by ply.

13. Overly strict requirements when projecting the material coordinate systems onto element planes.

14. Printing of the input DEBUG and MAPOL/EDIT packets even if NOLIST was requested.

15. Modules to calculate and print the SPC and MPC forces were developed. These have since been rendered incompatible with ASTROS Version 4 SAERO calculations, although they still work for STATICS.

16. The SHAPEGEN module was updated for Version 4 and installed as described in the ASTROS application manual. This module was used to generate all the shape functions for the fuselage and pod.

17. A module known as P3D was installed to download geometry and deformation data to a personal computer for graphic display using Northrop proprietary software.

3.8 INPUT DECK DATA FORMAT

ASTROS closely follows the COSMIC NASTRAN input with additions and modifications as necessary for optimization and multidisciplinary generality (e.g., aerodynamic input). The NASTRAN input will be for a nominal all metallic vehicle; the intent and primary involvement was to make an optimization model for the full vehicle structure.

Also included is an ASTROS compatible input deck with PCOMP type composites, steady and unsteady aerodynamic input, and full design model shape functions, DESVARs, and constraints.

SECTION 4

REFERENCES

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A P P E N D I X   A

ASTROS FULL-VEHICLE MODEL DEVELOPMENT AND CHECK RUN HISTORY

ASTROS FULL VEHICLE MODEL DEVELOPMENT AND CHECKOUT RUN HISTORY

DATES	FILE NAME	DESCRIPTION
12-29 JUNE	AA2EN AA2BN2	ANALYZE ONLY

STRUCTURE:
Fuselage, wing with spars perpendicular to centerline, pod, canard (spindle only), and vertical (mass only).
Fuselage & Pod: All 2024 aluminum,
.05 thick skins
.10 area longerons
Wing: Composite
specified by SHAPE type DESVARS (design variables)
Ribs and Spars .07 fabric all 45's
4 ply directions 0/+-45/90 for:
Skins .32 --> .04 tapered thickness
root tip
quasi isotropic initially
Leading edge & Aileron .08 constant thickness
63 / 25 / 12 percentages initially

Non-Structural Mass: CONM2 elements to reflect all parts of the aircraft not included in the structure. Non-structural mass of
57 slinches * 386lb/slinch = 22000lb whole vehicle

STEADY AERODYNAMICS:
Wing, canard, and fuselage (no vertical or pod)

	span		chord		
Wing:	10	x	10	=	100 aero panels
Canard:	8	x	7	=	56

Fuselage: 256 aero panels

	station		circumference		
Fwd	8	x	8	=	64
Mid(fwd)	4	x	16	=	64
Mid(aft)	2	x	17	=	34
Aft	6	x	10	=	60

Connection of Aerodynamics to Structure:
3 SPLINE1s connect the aero to wing stucture lower skin nodes: one inboard of the aileron, on forward of the aileron, and one on the aileron. ATTACHs connect the aero model of the canard to the spindle tip node. Each macro aero element on the fuselage connects via ATTACHs to a single GRID point. Because the transfer of load includes moments, these points must have rotational (bending) stiffness. Since designed QUADs/TRIAs do not have bending stiffness, only grid points with BARs attached were suitable. The scarcity of bending elements in the structure dictated the choice for ATTACHing aero to structure. In the Fwd Fuselage many stability BARs were available; the Mid Fuselage only has the canard spindle bars; and the Aft Fuselage has the engine mount bars.

DATES	FILE NAME	DESCRIPTION
	AA2BN	

*** Deleted orthogonality equations from the aero equations for reasonable computation times (2 hours to decompose stiffness matrix vs. >40). This destroys the physical relevance of the trim angle of attack and the flexible stability derivatives. ***

LOADS: All are ultimate = 1.5 * limit.

Static:

Nose landing gear impact

Main landing gear impact

conditions at 18 ft/sec sink rate (limit).

Steady aerodynamic:

Mach No.	Altitude	Load Factor (limit)
0.7	Sea Level	9 G's
0.7	Sea Level	-3
1.5	Sea Level	9

RESULTS:

Supersonic Steady Aerodynamics: is broken; calculates excessively high internal loads.

Subsonic Steady Aeroelasticity:

Trim: M .7 S.L.

	Rigid	Flexible	
Nz	13.5 G's	13.5 G's	
Alpha	17.65	?	(degrees angle of attack)
Delta	54.56	?	(degrees canard deflection)
Nz	1.0	1.0	
Alpha	-0.39	?	
Delta	15.66	?	
Nz	-4.5	-4.5	
Alpha	-8.33	?	
Delta	-1.46	?	

Displacements and internal loads values appeared to be within acceptable limits.

SPC and MPC Forces (by special subroutines, non-standard ASTROS)

MPC forces show the interface loads from structure to strucure, such as the wing to fuselage and forward fuselage to center fuselage, etc.

DATES	FILE NAME	DESCRIPTION
	AA2BN	COMMENTS: Steady aeroelastic results, even for rigid airframe, show that the configuration does not have enough canard lift/effectiveness to trim for reasonable drag at 1 G straight and level flight.
29 JUNE	AA2C	ANALYZE ONLY STRUCTURE: Same as AA2BN STEADY & UNSTEADY AERODYNAMICS: not used. LOADS: Static: One load case only, rigid aerodynamic load corresponding to Nz = 9 G's (limit) * 1.5 from REVWING at M 1.5 RESULTS: Internal Loads: significantly higher than for the aeroelastically corrected values from SAERO in AA2BN above for Nz = 9.
6-11 JULY	O2D	OPTIMIZE AND ANALYZE STRUCTURE: Similar to AA2BN, with modifications. Fuselage and pod- changed to composite, non-wing carry through BHDs and skins thickness of .10 with all 45 degree fabric; wing carry though BHDs typcially .45 thick; longerons changed to composite with 60% 0 degree orientation at 0.15 sq. in. area. Added SHAPE type DESVARS to fuselage and pod structures, generated by the SHAPEGEN function available within ASTROS version 1.0, as updated to work with version 3.0. Essentially all of the structure is assigned to DESVARs. OPTIMIZATION parameters: density of composite material increased by 50% to allow for non-optimum use of materials. CONSTRAINTS: Strain constraints corresponding to 180F notched allowables. Minimum gages - .010 each ply direction in wing skins. .040 total thickness for all other quads/trias. .12 area for longeron rods. Note: no general or panel buckling constraints in ASTROS. Deflection constraints available but not used.

DATES	FILE NAME	DESCRIPTION
	O2D	LOADS: 3 static loads. Rigid airloads from REVWING as in AA2C above. NLG and MLG landing impact cases.
Time(hrs) 53.6 CPU 61.3 elapsed		RESULTS: Optimization convergence in 9 iterations.

(lbm-sec**2/in = 'slinch'
1 slinch = 386 lb)

Weight & Mass for 1/2 aircraft

lb	slinch	
1409	3.65	Designed (structure, 5.17 slinch initial)
11000	28.52	Non-designed (non-strucuture)
12409	32.17	Total

21-26 JULY	O2E	OPTIMIZE AND ANALYZE

STRUCTURE and OPTIMIZATION parameters:
Same as O2D

LOADS:
2 static loads:
NLG and MLG landing impact case.
2 Steady Aeroelastic loads:
M .7 9 G's limit
M .7 -3 G's limit

RESULTS:
Time(hrs)
44.0 CPU
54.3 elapsed

Optimization convergence in 9 iterations.

Weight & Mass for 1/2 aircraft

lb	slinch	
1834	4.75	Designed (structure, 5.19 slinch initial)
11006	28.52	Non-designed (non-strucuture)
12840	33.26	Total

Subsonic Steady Aeroelasticity:
Trim: M .7 S.L.

	Rigid	Flexible	
Nz	13.5 G's	13.5 G's	
Alpha	25.22	?	(degrees angle of attack)
Delta	55.67	?	(degrees canard deflection)
Nz	-4.5	-4.5	
Alpha	-10.55	?	
Delta	-1.09	?	

DATES	FILE NAME	DESCRIPTION
	O2E	COMMENTS: Problems with the ATTACH cards that transfer loads from the aerodynamic model to the structure model: over loading the structure locally, inducing high stresses and hence heavy structure. Thse high local stresses were not anticipated and cannot be accomodated without severe weight impact. e.g. BHD228 thick = 2.75 in. We need the beam spline for the fuselage (part of the ASTROS enhancement package currently under development). Still no flexible trim.
01-04 AUG	O2F	OPTIMIZE AND ANALYZE STRUCTURE and OPTIMIZATION parameters: Similar to O2E. Added coordinate systems to define material orientation in composite elements. (Local x of the material - 0 degrees on PCOMP - is aligned with the x direction of the coordinate system called for on the element card. System 1 X aft Y right Z up (basic system) Wing skins/ribs and fuselage skins System 2 X right Y aft Z up Wing spars and BHDs Added composite material with quasi isotropic properties for use in top and bottom skins of fuselage, floors, and BHDs. Side skins, spars, and ribs remain all +-45 fabric Starting DESVARS values were set equal to the final values of the O2E run. Adjusted thickness of TRIA3 2248 in the SHAPE function to 5 times that of the rest of the elements on BHD228 to allow local thickness to respond to local high loads. Added SHAPE 2503 for fwd fuselage longeron which was inadvertently omitted from previous runs. LOADS: 2 static loads: NLG and MLG landing impact case. 2 Steady Aeroelastic loads: M .7 9 G's limit M .7 -3 G's limit

DATES	FILE NAME	DESCRIPTION
Time(hrs) 44.2 CPU 61.1 elapsed	O2F	RESULTS: Optimization convergence in 7 iterations.

Weight & Mass for 1/2 aircraft

lb	slinch	
1278	3.31	Designed (structure, 3.29 slinch initial)
11006	28.52	Non-designed (fixed,non-strucuture)
12280	31.82	Total

Subsonic Steady Aeroelasticity:
Trim: M .7 S.L.

	Rigid	Flexible	
Nz	13.5 G's	13.5 G's	
Alpha	22.72	?	(degrees angle of attack)
Delta	50.90	?	(degrees canard deflection)
Nz	-4.5	-4.5	
Alpha	-9.71	?	
Delta	-0.77	?	

COMMENTS:

Still have problems with the ATTACH cards transfering loads from the aerodynamic model to the structure model.

Still no flexible trim.

11-21 AUG O2G OPTIMIZE AND ANALYZE

STRUCTURE and OPTIMIZATION parameters:
Similar to O2F, set NRFAC = .62 to limit number of retained constraints to about 100.
SPC set added to eliminate SUPORT cards which do no work with generalized dynamic reduction.

STEADY AERODYNAMICS: Fixed the flexible trim parameter calculations with new ASTROS MAPOL executive sequence which rearranged the aerodynamic equations resulting in acceptable decomposition times without deleteint the orthogonality conditions as discussed in AA2BN run.

Changed to 8 ATTACHs on Fwd Fusleage to spread aero load over 8 GRIDs instead of 1.

DATES	FILE NAME	DESCRIPTION
	O2G	UNSTEADY AERODYNAMICS: Flutter considered. Supersonic body elements are not available in Unsteady Aerodynamics, so the lifting surfaces are extended to the vehicle centerline to approximate their effect. span chord Wing: 10 x 10 = 100 aero panels Canard: 8 x 7 = 56 (No vertical, not considered critical for preliminary design where only symmetric conditions are included.) Similar SPLINEs and ATTACHs as found in steady aero.
		EIGENSOLUTION: Generalized Dynamic Reduction (GDR) was used to solve for the subspace corresponding to frequencies below 15 Hz. Givens factorization yielded the actual frequencies and mode shapes for 12 modes, including 3 rigid body modes (pitch, plunge, and fore/aft directions.)
		LOADS: 2 static loads: NLG and MLG landing impact case. 2 Steady Aeroelastic loads: M .7 9 G's limit M .7 -3 G's limit
		FLUTTER: M 1.5 at sea level, constraint is damping <= 0. at 20080 in/sec velocity (M 1.5). Delete 3 rigid body modes from flutter analysis.
Time: Days Hours 8 0.2 CPU 10 2.6 elapsed		RESULTS: Optimization no convergence in 16 iterations (maxiter). ************** Flutter: Final iteration still had damping > 0. at 20080 in/sec. Mode Damping 1 2.06% 2 .43%

Weight & Mass for 1/2 aircraft

lb	slinch	
1722	4.46	Designed (structure, 3.29 slinch initial)
11006	28.51	Non-designed (fixed,non-strucuture)
12728	32.97	Total

DATES	FILE NAME	DESCRIPTION
	O2G	Subsonic Steady Aeroelasticity: Trim: M .7 S.L.

	Rigid	Flexible	
Nz	13.5 G's	13.5 G's	
Alpha	14.39	13.53	(degrees angle of attack)
Delta	48.22	60.00	(degrees canard deflection)
Nz	1.0	1.0	
Alpha	-.42	-.45	
Delta	15.60	17.75	
Nz	-4.5	-4.5	
Alpha	-6.94	-6.60	
Delta	1.29	-0.84	

COMMENTS:

Still have problems with the ATTACH cards transfering loads from the aerodynamic model to the structure model.

The dynamic mode shapes where flutter is a problem show large motions at the aft end of the pod; apparently the pod design variables are unable to provide sufficient authority to ASTROS to correct the flutter situation.

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28 AUG -07 SEP — **O2H** — OPTIMIZE AND ANALYZE

STRUCTURE and OPTIMIZATION parameters:
Similar to O2G, convert RODs in vertical to BARs to allow lateral motion at the tip of the vertical - the previous models were restrained laterally.
Density on the quasi-isotropic composite material MAT8 150 were corrected to include the 1.5 density factor. Added RODs on the top, bottom, and sides of the pod along with 2 DESVARS to allow the optimizer to stiffen the pod horizontally and vertically for flutter benefit. Also added ROD to connect the aft most fuselage frame to the pod to help stiffen it in lateral motion.

STEADY AERODYNAMICS: Same as O2G.

UNSTEADY AERODYNAMICS: Add vertical fin to model.

	span		chord	
Vertical:	8	x	7	= 56 aero panels

EIGENSOLUTION: Givens executed for 15 modes.

DATES	FILE NAME	DESCRIPTION
	O2H	LOADS: 2 static loads: NLG and MLG landing impact case. 2 Steady Aeroelastic loads: M .7 9 G's limit M .7 -3 G's limit
		FLUTTER: Similar to O2G, set GFAC to .4 to keep from getting gage thickness less than 0. as a consequence of excessively violated flutter constraints
Time: Days Hours 8 11.6 CPU 10 10.2 elapsed		RESULTS: Optimization no convergence in 16 iterations (maxiter). *************** Flutter: Final iteration still had damping > 0. at 20080 in/sec.

Mode	Damping
2	4.0%
3	3.3%
4	53.7%

Weight & Mass for 1/2 aircraft

lb	slinch	
1266	3.28	Designed (structure, 3.75 slinch initial)
11006	28.51	Non-designed (fixed,non-strucuture)
12272	31.79	Total

Subsonic Steady Aeroelasticity:

Trim: M .7 S.L.

	Rigid	Flexible	
Nz	13.5 G's	13.5 G's	
Alpha	13.24	13.11	(degrees angle of attack)
Delta	53.35	61.62	(degrees canard deflection)
Nz	1.0	1.0	
Alpha	-.50	-.31	
Delta	15.95	16.88	
Nz	-4.5	-4.5	
Alpha	-6.55	-6.62	
Delta	-0.50	-2.81	

DATES	FILE NAME	DESCRIPTION
	O2H	COMMENTS: Still have problems with the ATTACH cards transfering loads from the aerodynamic model to the structure model. The flutter problem is so severe that the aircraft configuration is now in question. Small improvements can clearly be made, but reducing the 50%+ damping value to zero will require a major structural change.
07 OCT -12 OCT Time: Days Hours 3 7.8 CPU 5+ elapsed	O2J	OPTIMIZE AND ANALYZE STRUCTURE and OPTIMIZATION parameters: Similar to O2H, changed landing impact load to 28000 lb, changed flutter altitude to 15000 ft because that is the minimum altitude for Mach 1.5 within the flight envelop, corrected (stiffened) the vertical fin to more acurately represent the torque box stiffness in bending and torsion. STEADY AERODYNAMICS: Same as O2H. UNSTEADY AERODYNAMICS: Same as O2H. EIGENSOLUTION: Same as O2H. LOADS: Same as O2H. FLUTTER: Similar to O2H, omitted undamped modes 7 & 11 since they were not influencing the flutter behavior but were interfering with the flutter optimization. RESULTS: Optimization was conducted 1 iteration at a time to allow adjusting parameters between iterations to fine tune the optimization process. After adding 35% weight in 3 iterations the optimizer was unable to find a feasible direction to move the design point. Maybe the optimizer is confused.

DATES	FILE NAME	DESCRIPTION
	O2J	Flutter: Mode 1 is the only one with positive damping. Final iteration still had damping > 0. at 19027 in/sec.

Mode	Damping
1	3.1%

Weight & Mass for 1/2 aircraft

lb	slinch	
2007	5.18	Designed (structure, 3.75 slinch initial)
11006	28.51	Non-designed (fixed,non-strucuture)
13013	33.67	Total

Subsonic Steady Aeroelasticity:
Trim: M .7 S.L.

	Rigid	Flexible	
Nz	13.5 G's	13.5 G's	
Alpha	14.51	14.71	(degrees angle of attack)
Delta	50.29	53.77	(degrees canard deflection)
Nz	-4.5	-4.5	
Alpha	-6.98	-6.94	
Delta	0.55	-0.58	

COMMENTS:

Still have problems with the ATTACH cards transfering loads from the aerodynamic model to the structure model.

The flutter problem helped uncover the software error in the flutter sensitivity spill logic. Correction of the logic did not help in eliminating mode 1 flutter from the N382-20. Some excessively flexible locations in the fuselage were uncovered in the mode shapes.

DATES	FILE NAME	DESCRIPTION
13 OCT -25 OCT	O2K	OPTIMIZE AND ANALYZE STRUCTURE and OPTIMIZATION parameters: Similar to O2J, deepened the fuselage frames at stations 520 and 648 and stiffened the forward fuselage upper longeron in lateral bending to correct the low frequency mode shapes. STEADY AERODYNAMICS: Was omitted from the early iterations to avoid confusing the optimizer. UNSTEADY AERODYNAMICS: Same as O2J. EIGENSOLUTION: Same as O2J. LOADS: Took out SAERO put the rigid air loads from REVWING back in. FLUTTER: Similar to O2J, omitted undamped modes 9 & 10 since they were not influencing the flutter behavior but were interfering with the flutter optimization.
Time: 4hrs/iteration (flutter only)		RESULTS: This version was also run 1 iteration at a time. The runs have not finished yet, but microDOT parameter changes appear to resolve the search direction difficulties.

A P P E N D I X B

WEIGHT AND BALANCE SPREAD SHEETS FOR NON-STRUCTURAL MASS OF ASTROS MODEL

		KLS	ACTUAL	SHIFT	WT*X(KLS)	WT*X(act)								WT*STA	WT*STA	SUM WT
DESCRIPTION	weight	X(IN)	STA x(in)	50.0	x in-lb	x in -lb	NODES	WT/NODE	STA	NODES	WT RECON	SLIN/NODE	SLIN/STA	NODES	INPUT	INPUT
RADOME	123	105	155		1.292E+4	1.907E+4	9	13.67	175.00	2001-2009	123.03	0.0177	0.1594	21530	19065	123
NLG (UP)	115	171	221		1.967E+4	2.542E+4	1	55.00	194.88	2057-	55.00	0.0712	0.0712	10718	25415	238
NLG(DOWN)		146	196									0.0000	0.0000			
TOW BAR(FUR	5	195	245		9.750E+2	1.225E+3	1	65.00	245.00	2140-	65.00	0.0842	0.0842	15925	1225	243
AVIONICS	0	155	205		0.000E+0	0.000E+0					0.00	0.0000	0.0000	0	0	243
INSTRUMENTS	90	205	255		1.845E+4	2.295E+4	1	90.00	255.08	2165-	90.00	0.1166	0.1166	22957	22950	333
CANOPY/WIND	240	227	277		5.448E+4	6.648E+4	1	24.00	215.00	2089-	24.00	0.0311	0.0311	5160	66480	573
							1	24.00	210.00	2090-	24.00	0.0311	0.0311	5040	0	573
							1	24.00	228.40	2109-	24.00	0.0311	0.0311	5482	0	573
							1	24.00	245.00	2139-	24.00	0.0311	0.0311	5880	0	573
							1	24.00	255.08	2159-	24.00	0.0311	0.0311	6122	0	573
							1	24.00	268.75	2178-	24.00	0.0311	0.0311	6450	0	573
							1	24.00	282.23	2198-	24.00	0.0311	0.0311	6774	0	573
							1	24.00	299.00	2216-	24.00	0.0311	0.0311	7176	0	573
							1	24.00	305.00	2228-	24.00	0.0311	0.0311	7320	0	573
							1	24.00	330.00	2248-	24.00	0.0311	0.0311	7920	0	573
CREW	230	227	277		5.221E+4	6.371E+4	3	76.67	268.75	2182-3-4	230.01	0.0993	0.2979	61815	63710	803
FURNSH-SEAT	230	227	277		5.221E+4	6.371E+4	3	76.67	282.23	2202-3-4	230.00	0.0993	0.2979	64913	63710	1033
											0.00	0.0000	0.0000	0	0	1033
FURN/ARM=46	0	240	290		0.000E+0	0.000E+0					0.00	0.0000	0.0000	0	0	1033
NOZZLE CNTL	436	260	310		1.134E+5	1.352E+5	3	204.70	305.00	2224-5-6	614.10	0.2652	0.7955	187301	135160	1469
RALS NOZZLE	178	260	310		4.628E+4	5.518E+4					0.00	0.0000	0.0000	0	55180	1647
RALS DUCT B	100	320	370		3.200E+4	3.700E+4	3	13.30	330.00	3018-20-26	39.90	0.0172	0.0517	13167	37000	1747
RALS DUCTS	100	320	370		3.200E+4	3.700E+4	3	13.30	360.00	3108-10-13	39.90	0.0172	0.0517	14364	37000	1847
							3	13.30	390.00	3179-81-84	39.90	0.0172	0.0517	15561	0	1847
							3	13.30	420.00	3225-27-30	39.90	0.0172	0.0517	16758	0	1847
							3	13.30	454.00	3268-72-74	39.90	0.0172	0.0517	18115	0	1847
FUS FUEL	5412	340	390		1.840E+6	2.111E+6						0.0000	0.0000	0	2110680	7259
AIR INDUCTIO	694	350	400		2.429E+5	2.776E+5	1	0.00	400.00		0.00	0.0000	0.0000	0	277600	7953
CANARD	319	319	369		1.018E+5	1.177E+5	1	319.00	369.00	3138-	319.00	0.4132	0.4132	117711	117711	8272
GUN SYSTEM	602	355	405		2.137E+5	2.438E+5	1	186.00	365.00	3132-	186.00	0.2409	0.2409	67890	243810	8874
GUN BAY-FUR	88	355	405		3.124E+4	3.564E+4	1	504.00	420.00	3217-	504.00	0.6528	0.6528	211680	35640	8962
MISSILE	934	370	420		3.456E+5	3.923E+5	2	369.50	360.00	3091-2	739.00	0.4786	0.9573	266040	392280	9896
MSL SUSP EQ	300	370	420		1.110E+5	1.260E+5	2	369.50	474.50	3291-2	739.00	0.4786	0.9573	350656	126000	10196
WEAPONS PAI	100	370	420		3.700E+4	4.200E+4					0.00	0.0000	0.0000	0	42000	10296
MSL ARMING	144	370	420		5.328E+4	6.048E+4					0.00	0.0000	0.0000	0	60480	10440
FUSELAGE	2636	380	430		1.002E+6	1.133E+6	1	0.00	430.00		0.00	0.0000	0.0000	0	1133480	13076
AMMO.	278	382	432		1.062E+5	1.201E+5	1	0.00	432.00		0.00	0.0000	0.0000	0	120096	13354
ELECTRICAL	220	400	450		8.800E+4	9.900E+4	1	191.00	201.50	2075-	191.00	0.2474	0.2474	38487	99000	13574
HYDR & PNEU	123	400	450		4.920E+4	5.535E+4	1	152.00	648.50	4165-	152.00	0.1969	0.1969	98572	55350	13697
FLIGHT CNTL	521	420	470		2.188E+5	2.449E+5	1	40.00	245.00	2141-	40.00	0.0518	0.0518	9800	244870	14218
							1	160.00	268.75	2180-	160.00	0.2073	0.2073	43000	0	14218
							1	160.00	581.00	4105-	160.00	0.2073	0.2073	92960	0	14218
							1	161.00	637.00	1115-	161.00	0.2085	0.2085	102557	0	14218
SCROLL	338	430	480		1.453E+5	1.622E+5	1	224.00	454.00	3270-	224.00	0.2902	0.2902	101696	162240	14556
							1	114.00	531.00	4058-	114.00	0.1477	0.1477	60534	0	14556
FUEL SYSTEM	347	440	490		1.527E+5	1.700E+5	1	174.00	330.00	3013-	174.00	0.2254	0.2254	57420	170030	14903
							1	173.00	640.00	1135-	173.00	0.2241	0.2241	110720	0	14903
ENG ACCESSO	340	460	510		1.564E+5	1.734E+5	3	94.30	495.50	4014-5-8	282.90	0.1222	0.3665	140177	173400	15243

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		KLS	ACTUAL	SHIFT	WT*X(KLS)	WT*X(act)								WT*STA	WT*STA	SUM WT
ELEC&H&P	343	460	510		1.578E+5	1.749E+5	2	200.00	520.25	4044-5	400.00	0.2591	0.5181	208100	174930	15586
AIRCON(ECS/	468	464	514		2.172E+5	2.406E+5	2	59.00	495.50	4005-6	118.00	0.0764	0.1528	58469	240552	16054
							2	175.00	520.25	4035-6	350.00	0.2267	0.4534	182088	0	16054
ENGINE	2000	480	530		9.600E+5	1.060E+6	1	2086.00	530.00	4058-	2086.00	2.7021	2.7021	1105580	1060000	18054
WING	2049	493	543		1.010E+6	1.113E+6	1	0.00	543.00		0.00	0.0000	0.0000	0	1112607	20103
WING FUEL	3030	495	545		1.500E+6	1.651E+6	1	0.00	545.00		0.00	0.0000	0.0000	0	1651350	23133
AVIONICS	1180	499	549		5.888E+5	6.478E+5	1	0.00	548.65		0.00	0.0000	0.0000	0	647820	24313
ENG SECTION	113	500	550		5.650E+4	6.215E+4	1	27.00	615.00	4139-	27.00	0.0350	0.0350	16605	62150	24426
MLG (UP)	1010	543	593		5.484E+5	5.989E+5	1	455.00	565.00		455.00	0.5894	0.5894	257075	598930	25436
MLG (DOWN)		513	563				1	556.00	615.00	5053-	556.00	0.7202	0.7202	341940	0	25436
AB/VABI	276	545	595		1.504E+5	1.642E+5	2	81.00	581.00	4109-10	162.00	0.1049	0.2098	94122	164220	25712
							2	57.00	615.00	4139-40	114.00	0.0738	0.1477	70110	0	25712
SERN	365	585	635		2.135E+5	2.318E+5	2	73.50	615.00	4139-40	147.00	0.0952	0.1904	90405	231775	26077
							3	72.60	648.50	4169-70-71	217.80	0.0940	0.2821	141243	0	26077
TAIL BOOMS	765	600	650		4.590E+5	4.973E+5	1	0.00	650.00		0.00	0.0000	0.0000	0	497250	26842
POD FUEL	920	625	675		5.750E+5	6.210E+5	3	87.67	655.00	5083-4-5	263.01	0.1136	0.3407	172272	621000	27762
							3	175.33	680.00	5103-4-5	525.99	0.2271	0.6813	357673	0	27762
							3	43.83	695.00	5123-4-5	131.49	0.0568	0.1703	91386	0	27762
V TAIL	371	680	730		2.523E+5	2.708E+5	1	130.00	695.00	5129-	130.00	0.1684	0.1684	90350	270830	28133
							1	130.00	735.00	5149-	130.00	0.1684	0.1684	95550	0	28133
							1	55.00	770.00	5133-	55.00	0.0712	0.0712	42350	0	28133
							1	56.00	782.60	5153-	56.00	0.0725	0.0725	43826	0	28133
TOTAL WT	28133	72.88			1.202E+7	1.342E+7				NSM SO FAR	12090	15.6604	15.6604	5.86E+6		
	LB	SLINCH												484.33	CG STA	
										NSM	LB	SLINCH	CG			
										NSM SO FAR	12090	15.6604	484.33	5855467		
						CG STA(IN)				FUEL FUSE	5690	7.3705	389.67	2217222		
					427.197	477.197				FUEL WING	3030	3.9249	548.12	1660804		
										AVIONICS	1180	1.5285	548.65	647407		
										NSM SUBTOT	21989.8	28.48424		10380900		
														472.08	CG STA	
										STRUCTURE						
										AIR INDUC	694	0.8990	400.00	277600		
										FUSE	2636	3.4145	430.00	1133480		
										WING	2049	2.6541	543.00	1112607		
										TAIL BOOM	765	0.9909	650.00	497250		
										STRUC SUBTO	6144	7.9585		3020937		
														491.69	CG STA	
										TOTAL	28133.8	36.4428		1340183		
														476.36	CG STA	

AVIONICS				0.902	FACTOR		NODES	WT/NODE	STA		slin/node	slin/sta		
ESA RADAR	131	118	168.00	118.2		1.985E+4	2	59.10	175.00	2015-2021	0.0766	0.1531	2.069E+4	2.069E+4
laser track etc						0.000E+0	2	49.40	175.00	2012-2013	0.0640	0.1280	1.729E+4	3.798E+4
LASER TRACK	72	130	180.00	64.9		1.169E+4	2	24.60	188.25	2057-2058	0.0319	0.0637	9.262E+3	4.724E+4
RF EQUIP	114	140	190.00	102.8		1.954E+4	2	10.00	194.88	2044-2045	0.0130	0.0259	3.898E+3	5.113E+4
CNTL/DISPL	72	200	250.00	64.9		1.624E+4	1	32.50	245.00	2145-	0.0421	0.0421	7.963E+3	5.910E+4
						0.000E+0	1	32.50	255.08	2165-	0.0421	0.0421	8.290E+3	6.739E+4
VENTRAL ANT	22	370	420.00	19.8		8.334E+3	1	19.80	420.00	3191-	0.0256	0.0256	8.316E+3	7.570E+4
DORSAL ANTE	33	450	500.00	29.8		1.488E+4	1	35.20	495.50	3341-	0.0456	0.0456	1.744E+4	9.314E+4
LPI ALTIMETE	6	450	500.00	5.4		2.706E+3	0	0.00	495.50	-	0.0000	0.0000	0.000E+0	9.314E+4
PAVE PILLAR	396	660	710.00	357.2		2.536E+5	3	137.56	695.00	5122-26-31	0.1782	0.5346	2.868E+5	3.800E+5
PAVE PILLAR	336	660	710.00	303.1		2.152E+5	3	82.54	735.00	5142-46-51	0.1069	0.3208	1.820E+5	5.620E+5
ECM DISP/SEN	101	700	750.00	91.1		6.833E+4	1	56.85	751.00	5171-	0.0736	0.0736	4.269E+4	6.047E+5
CHAFF	25	700	750.00	22.6		1.691E+4	1	56.85	751.00	5172-	0.0736	0.0736	4.269E+4	6.473E+5
SUM(UNFCTRI	1308		SUM(FCTR	1179.8	SUM LB	6.473E+5						1.5288	6.473E+5	
				3.0565	SLIN TOTAL	548.615	CG							
FUSELAGE FUE	6332			1.5283	SLIN 1/2									
POD FUEL	-920													
NET FUS FUEL	5412													
AMMO-ADD TO	278													
FUSELAGE FUE	5690	350	400.00		3.990E-2									
STA	LENGTH	WIDTH	DEPTH	VOL	WT	WT*STA	NODES	WT/NODE			slin/node	siin/sta		
330	15	19.35	55.00	15964	636.9	2.102E+5	4	159.2	330.0	3012-13-14-	0.2063	0.8250	2.102E+5	
360	30	20.80	55.00	34320	1369.3	4.930E+5	4	342.3	360.0	3102-3-4-95	0.4434	1.7737	4.930E+5	
390	30	24.08	55.00	39732	1585.3	6.183E+5	4	396.3	390.0	3157-8-9-45	0.5134	2.0534	6.183E+5	
390	15	4.11	33.00	2034	81.2	3.166E+4	2	40.6	390.0	3162-3147	0.0526	0.1051	3.166E+4	
420	32	16.74	55.00	29462	1175.5	4.937E+5	3	391.8	420.0	3206-07-08	0.5076	1.5227	4.937E+5	
420	32	8.20	33.00	8659	345.5	1.451E+5	2	172.7	420.0	3214-3197	0.2238	0.4475	1.451E+5	
454	17	4.97	55.00	4647	185.4	8.417E+4	2	92.7	454.0	3254-3255	0.1201	0.2402	8.417E+4	
454	17	13.89	33.00	7792	310.9	1.411E+5	2	155.5	454.0	3258-3246	0.2014	0.4027	1.411E+5	
				142611	5690	2.217E+6						7.3705	2.217E+6	
					14.7409	389.67								
					7.3705									

WING FUEL	3030	495	545		1.500E+6	1.651E+6										
	WEIGHT	X(IN)	STA(IN)		WT*X(KLS)	WT*X(ACT)	NODES	WT/NODE	STA	BL	node	slin/NODE	WT*STA	WT*BL		
	7.8497	SLINCH TOTAL					1	48.90	454.000	41.000	1003-	0.0633	2.220E+4	2.005E+3		
	3.9249	SLINCH 1/2					1	105.74	495.500	34.909	1005-	0.1370	5.239E+4	3.691E+3		
							1	97.74	520.250	34.909	1007-	0.1266	5.085E+4	3.412E+3		
							1	97.74	545.000	34.909	1009-	0.1266	5.327E+4	3.412E+3		
							1	97.74	581.000	34.909	1011-	0.1266	5.679E+4	3.412E+3		
							1	40.90	615.000	34.909	1013-	0.0530	2.515E+4	1.428E+3		
							1	97.74	476.007	59.000	1023-	0.1266	4.652E+4	5.767E+3		
							1	195.48	495.500	59.000	1025-	0.2532	9.686E+4	1.153E+4		
							1	195.48	520.250	59.000	1027-	0.2532	1.017E+5	1.153E+4		
							1	195.48	545.000	59.000	1029-	0.2532	1.065E+5	1.153E+4		
							1	195.48	581.000	59.000	1031-	0.2532	1.136E+5	1.153E+4		
							1	97.74	615.000	59.000	1033-	0.1266	6.011E+4	5.767E+3		
							1	97.74	495.500	78.688	1065-	0.1266	4.843E+4	7.691E+3		
							1	195.48	520.250	78.688	1067-	0.2532	1.017E+5	1.538E+4		
							1	195.48	545.000	78.688	1069-	0.2532	1.065E+5	1.538E+4		
							1	195.48	581.000	78.688	1071-	0.2532	1.136E+5	1.538E+4		
							1	97.74	615.000	78.688	1073-	0.1266	6.011E+4	7.691E+3		
							1	97.74	520.250	103.681	1087-	0.1266	5.085E+4	1.013E+4		
							1	195.48	545.000	103.681	1089-	0.2532	1.065E+5	2.027E+4		
							1	195.48	581.000	103.681	1091-	0.2532	1.136E+5	2.027E+4		
							1	97.74	615.000	103.681	1093-	0.1266	6.011E+4	1.013E+4		
							1	48.84	545.000	128.685	1109-	0.0633	2.662E+4	6.285E+3		
							1	97.74	581.000	128.685	1111-	0.1266	5.679E+4	1.258E+4		
							1	48.84	615.000	128.685	1113-	0.0633	3.004E+4	6.285E+3		
												3.925	1.661E+6	2.225E+5		
													548.125	73.434		
													STA	BL		

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A P P E N D I X   C

COMPLETE ASTROS INPUT DATA FILE

```
ASSIGN DATABASE O2K KIMBERLY NEW
DEBUG
  LOGBEGIN
SOLUTION
$
   TITLE   = N382 STOVL FUS/WING2/POD STRUC // WING CANARD FUSELAGE AERO (O2K)
 SUBTITLE = RH HALF MODEL SPARS PERPENDICULAR TO CENTERLINE  - CANARD 24IN FWD
$
OPTIMIZE  STRATEGY = MP, NRFAC = 0.62, MAXITER = 1
$
 BOUNDARY  SPC = 9910, MPC = 5510, DYNRED = 440, METHOD = 441
  PRINT ROOT = 455, DISP = 997, MODES = 448, DESIGN, DCON
   MODES
     LABEL = MODAL ANALYSIS
   FLUTTER ( FLCOND = 102, DCON = 100 )
     LABEL = FLUTTER M = 1.5  15000 FT    ADD VERTICAL AERO  BARS ON PODS
$
 BOUNDARY  SPC = 5510, MPC = 5510, SUPPORT = 10
  PRINT DISP = 997, ACCE = 995, DCON, DESIGN, TRIM
$
   STATICS ( MECH = 28000 )
     LABEL = NOSE GEAR LANDING IMPACT 8.51G'S ULT  28331 LB
   STATICS ( MECH = 74000 )
     LABEL = MAIN GEAR LANDING IMPACT 6.91G'S ULT  73758 LB
$
    SAERO ( TRIM = 70   )
     LABEL = MACH .7 SL   13.5G SYMM
    SAERO ( TRIM = 74   )
     LABEL = MACH .7 SL   -4.5G SYMM
$
END
$ - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
ANALYZE
 BOUNDARY  SPC = 5510, MPC = 5510, SUPPORT = 10
  PRINT DISP = 997, ACCE = 995, FORC = ALL, SPCF = ALL, TRIM, LOAD = ALL
$
   STATICS ( MECH = 28000 )
     LABEL = NOSE GEAR LANDING IMPACT 8.51G'S ULT  28331 LB
    STATICS ( MECH = 74000 )
     LABEL = MAIN GEAR LANDING IMPACT 6.91G'S ULT  73758 LB
$
    SAERO ( TRIM = 70   )
     LABEL = MACH .7 SL   13.5G SYMM
    SAERO ( TRIM = 71   )
     LABEL = MACH .7 SL    1.0G SYMM
    SAERO ( TRIM = 74   )
     LABEL = MACH .7 SL   -4.5G SYMM
$
 BOUNDARY  SPC = 9910, MPC = 5510, DYNRED = 440, METHOD = 441
  PRINT ROOT = 455, DISP = 997, MODES = 448, DESIGN, DCON
   MODES
     LABEL = MODAL ANALYSIS
   FLUTTER ( FLCOND = 100 )
```

```
     LABEL = FLUTTER M = 1.5  15000 FT    ADD VERTICAL AERO  BARS ON PODS
$
END
BEGIN BULK
$-------2-------3-------4-------5-------6-------7-------8-------9------
$
$
$ BOUNDARY  SPC = 5510, MPC = 5510, SUPPORT = 10
$   PRINT TRIM,  DISP = 997, FORC = ALL, ACCE = 995, SPCF = ALL
$    SAERO ( TRIM = 150  )
$     LABEL = MACH 1.5 SL  13.5G SYMM
$
$   STATICS ( MECH = 13 )
$    PRINT DISP = 997, FORC = ALL, SPCF = ALL, LOAD = ALL
$     LABEL =  M 1.2 SEA LEVEL SYMM PULL UP  13G.S=12G.S * 1.125 FROM REVWING
$
$ BOUNDARY  SPC = 11, MPC = 5511, SUPPORT = 11, REDUCE=11
$   SAERO ( TRIM = 444, DCON = 444 )
$   PRINT DCON, TRIM, DISP = 998
$
$:CORD2R-CID----RID-----A1------A2------A3------B1------B2------B3------
$
$ CORD 1 CORD SYSTEM FOR MAT SYSTEM ON FUSELAGE SKINS, WING RIBS
$          LOCAL X = AFT (PARALLEL TO BASIC SYSTEM)
CORD2R  1               0.      0.      0.      0.       0.0     1.0     +CORD1
+CORD1  1.      0.      0.
$
$ CORD 2 CORD SYSTEM FOR WING SKINS & SPARS, FUSELAGE BHDS/FRMS
$          LOCAL X = INBD/OUTBD (BASIC Y)
CORD2R  2               0.      0.      0.      0.       0.0     1.0     +CORD2
+CORD2  0.      1.      0.
$
$ CORD 45 CORD SYSTEM FOR LEADING EDGE SKIN
$           LOCAL X = 45 DEGRS AFT FROM HORIZONTAL TO RIGHT
CORD2R  45              0.      0.      0.      0.       0.0     1.0     +CORD45
+CORD45 0.707   0.707   0.
$
$ --- MATERIAL CARDS COLLECTED TOGETHER
$ --- FOR ALL FUSELAGE / WING / POD SEGMENTS
$
$:MAT8--MID-----E1------E2------NU12----G12-----G1Z-----G2Z-----RHO-----+
$
$ --- GRAPHITE PROPERTIES UNI NOMINAL ULW MATL IM7/PEEK PER H.R.ZAMANI 89/5/31
$ ---  180F PROPERTIES - NOTCHED ALLOWABLES - DENSITY = 1.5* NOMINAL
$
$MAT8     50      21.50E6 1.3E6   .35     0.510E6 .51E6   .51E6   .148-3 +M50
MAT8     50      21.50E6 1.3E6   .35     0.510E6 .51E6   .51E6   .225-3 +M50
+M50     .33-6   16.-6   70.     5800.   4200.   5800.   10000.  13100.
$:+MAT8-A1------A2------TREF----STX-----SCX-----STY-----SCY-----TAU-----+
$
$ --- GRAPHITE PROPERTIES 133 STYLE FABRIC (APPROX PROP'S FOR IM7/PEEK)
$
$MAT8     133     10.50+6 10.50+6 .05     0.510E6 .51E6   .51E6   .148-3 +M133
MAT8     133     10.50+6 10.50+6 .05     0.510E6 .51E6   .51E6   .225-3 +M133
```

```
+M133                   70.     5800.   4200.   5800.   4200.   13100.
$
$ --- KEVLAR 49      PROPERTIES UNI   UNNOTCHED
$
$MAT8      49     9.900E6 .72E6   .34     0.270E6 .27E6   .27E6   .124-3 +M49
MAT8      49     9.900E6 .72E6   .34     0.270E6 .27E6   .27E6   .186-3 +M49
+M49                            16160.  3230.   5340.   22230.  25770.
$
$ --- KEVLAR 49      PROPERTIES 120 STYLE CLOTH
$
$MAT8     120     4.05+6  4.05+6  .10     0.270E6 .27E6   .27E6   .124-3 +M120
MAT8     120     4.05+6  4.05+6  .10     0.270E6 .27E6   .27E6   .186-3 +M120
+M120                           14800.  4500.   14800.  4500.   20400.
$
$ --- AS4/BMI 375DEG F
MAT8     5250    18.65+6 1.15+6  .32     .37+6   .37+6   .37+6   .148-3 +M5250
+M5250   -2.-6   12.1-6  70.
$
$
$:MAT1--MID-----E-------G-------NU------RHO-----A-------TREF----GE------
$ ---  MAT  150
$ --- QUASI ISO APPROX FOR IM7-PEEK
$
$MAT1     150     7.30+6          .3      .148-3  2.-6    70.            +M150
MAT1     150     7.30+6          .3      .225-3  2.-6    70.            +M150
+M150    42000.  31000.  20000.
$
$ --- MAT 409 IS FOR RODS - DESIGNED GRAPHITE COMPOSITE
$ ---                        NOMINAL MODULUS/STRENGTHS
$MAT1     409     15.0+6          0.33    .148-3  2.-6    70.            +M409
MAT1     409     15.0+6          0.33    .225-3  2.-6    70.            +M409
+M409    75000.  63000.
$
$ --- NOMINAL ALUMINUM PROPETIES WITH AND WITHOUT MASS DENSITY
$
MAT1     2023    10.4+6          0.33            13.-6   70.
MAT1     2024    10.4+6          0.33    .259-3  13.-6   70.
$
$ --- NOMINAL TITANIUM PROPETIES WITH AND WITHOUT MASS DENSITY
$
MAT1     7163    16.0+6          0.33            5.-6    70.
MAT1     7164    16.0+6          0.33    .400-3  5.-6    70.
$
$ --- NOMINAL STEEL PROPETIES WITH AND WITHOUT MASS DENSITY
$
MAT1     4339    29.0+6          0.33            6.-6    70.
MAT1     4340    29.0+6          0.33    .733-3  6.-6    70.
MAT1     1410    30.0+6          0.33    .733-3  6.-6    70.
$
$ --- PROPERTY CARDS COLLECTED TOGETHER
$ --- FOR ALL FUSELAGE / WING / POD SEGMENTS
$
$:PROD--PID-----MID-----A-------J-------C-------NSM-----TMIN----
$
```

```
$ --- PROD 1 IS FOR THE DESIGNED COMPOSITE RODS
$PROD          1     2024      .1
PROD          1     409      .15                                    .12
$
PROD       3599    4340      .11
$
$PROD      4114     2024      .5                                    .12
PROD       4114     409      .5                                     .12
$
$:PBAR--PID-----MID-----A-------I1------I2------J-------NSM-----TMIN----
PBAR         71     2023      .3       .62      .62      .62
PBAR        113     2023      .3       .62      .62
PBAR       2010     2023    0.       0.05      .05      .05
PBAR       2710     2023    0.       0.5      2.5       .2
PBAR       3701     4339    0.5      2.5      2.5      5.
PBAR       4655     4339    0.3      1.       1.        .1
PBAR       5411     2023   13.5     100.     600.     30.
$
$:PSHELL PID----MID1----T-------MID2----12I/T**3-MID3---TS/T----NSM-----
$
$PSHELL       1      2024     0.050
$PSHELL      50      2024     0.05
PSHELL       70     2024    0.07
PSHELL       80     2024    0.08
PSHELL      100     2024    0.1
$
$PQDMEM1 ID---- MID-----T------ NSM----
$PQDMEM1     50      2024     0.050
$
$PTRMEM       1      2024     0.050
$PTRMEM      50      2024     0.050
$
$PCOMP--PID-----ZO------NSM-----SB------F.T.----TMIN----GE-------------
$
$ --- WING SKINS - ALL UNI - 0/+45/-45/90  4 PLY ORIENTATIONS
$
PCOMP    1001                                    .010            MEM      +P1001A
+P1001A   50      .012      0.      YES      50      .012    45.    YES      +P1001B
+P1001B   50      .012    -45.      YES      50      .012    90.    YES
$
$ --- WING SPARS & RIBS, FUSELAGE SIDE SKINS, DUCTS - 100% 45'S (FABRIC)
$
PCOMP    1                                       .040            MEM      +P1
+P1       133     .050      45.     YES
$
PCOMP    50                                      .C40            MEM      +P50
+P50      133     .050      45.     YES
$
PCOMP    1002                                    .040            MEM      +P1002A
+P1002A   133     .050      45.     YES
$
$ --- FUSELAGE TOP & BOTTOM SKINS, BHDS, FRAMES, FLOORS - QUASI ISO
$
PCOMP    1003                                    .040            MEM      +P1003A
```

```
+P1003A   150     .050      0.      YES
$
$
$ - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
$
$GRIDLST SID----GID1----GID2----GID3----GID4----GID5----GID6----GID7
GRIDLIST  998        1    THRU       17
GRIDLIST  998       99
GRIDLIST  998     1001    THRU     1017
GRIDLIST  998     1141    THRU     1159
$
$GRIDLST SID----GID1----GID2----GID3----GID4----GID5----GID6----GID7
GRIDLIST  997       99
GRIDLIST  997     1001    THRU     1017
GRIDLIST  997     1141    THRU     1159
GRIDLIST  997     1701    1049     1051     2057     2044     2074
GRIDLIST  997     3120    3133     3138     3149
GRIDLIST  997     4058    4036     4038     4066     4068
GRIDLIST  997     2001    2052     2082     2132     2171     2221
GRIDLIST  997     3001    3091     3141     3191     3241     3291
GRIDLIST  997     4001    4031     4061     4091     4121     4151
GRIDLIST  997     5001    5021     5061     5101     5121     5141     5161
GRIDLIST  997     5133    5153
$
$GRIDLST SID----GID1----GID2----GID3----GID4----GID5----GID6----GID7
GRIDLIST  995       99
GRIDLIST  995     1003    1065     1109     1151
GRIDLIST  995     1013    1075     1115     1155
GRIDLIST  995     2001    2052     2082     2132     2171     2221
GRIDLIST  995     3001    3091     3141     3191     3241     3291
GRIDLIST  995     4001    4031     4061     4091     4121     4151
GRIDLIST  995     5001    5021     5061     5101     5121     5141     5161
$
$MODELST SID----GID1----GID2----GID3----GID4----GID5----GID6----GID7
MODELIST  440        1    THRU        6
MODELIST  446        1    THRU        6
MODELIST  447        1    THRU        7
MODELIST  448        1    THRU        8
MODELIST  455        1    THRU       15
$
$       RESEQUENCING DATA FROM MSC/NASTRAN BASED ON ASTROS AA2B MODEL
$                           08-JUNE-1989
$
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$SEQGP          2037    10037     2010    10038     2009    10039     2008    10040
$SEQGP          2038    10041     2039    10042     2040    10043     2041    10044
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$SEQGP        1078    10869    1079    10870
$
$ - - - - - - - - - - - - - - - - - - -
$ --- FROM NASTRAN MODEL WITHOUT REF GRID 99
$ ---  AXIAL SUPORT AT FWD BHD
$ --- PITCH AND PLUNGE SUPORT DIRECTIONS - VERTICAL FWD AND AFT
$
$SUPORT-SID-----ID1-----C1------ID2-----C2------ID3-----C3------
SUPORT   222     2004    1
SUPORT   222     2001    3       4155    3
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$
$:NASTRAN  NO SET ID SPECIFIER, ONLY ONE SET PER RUN ALLOWED
$:SUPORT ID-----C-------ID------C-------ID------C-------
$SUPORT   99      35
$SUPORT   99       4
$
$:ASTROS
$:SUPORT SID----ID-----C-------ID------C-------ID------C-------
SUPORT   10      99      35
SUPORT   11      99      4
$
$:SPCADD SID----S1------S2------S3------S4------S5------S6------
$ --- SPC  5510 FOR   SYMMETRIC BC'S    246  FOR SAERO W/ SUPORTS 3 & 5
SPCADD    5510   55      10
$
$ --- SPC  9910 FOR   SYMMETRIC BC'S    246  FOR GDR W/O SUPORTS
SPCADD    9910   99      10
$
$
$:SPC1--SID-----C-------G1------G2------G3------G4------G5------G6------
$ --- SPC  55 FOR     SYMMETRIC BC'S    246  FOR SAERO W/ SUPORTS 3 & 5
SPC1     55     1246     99
$
$ --- SPC  99 FOR     SYMMETRIC BC'S    246  FOR GDR W/O SUPORTS
SPC1     99      246     99
$
$ --- SPC 11 FOR ANTISYMMETRIC BC'S    135
SPC1     11      12356   99
$
$:MPCADD SID----S1------S2------S3------S4------S5------S6------
$
$ --- MPC 55 CONNECT STRUCTURE SEGMENTS TOGETHER INTERNALLY
$
MPCADD   5510    55      10
MPCADD   5511    55      11
$
$ --- MPC'S BELOW CONNECT CENTERLINE NODES  TO THE SUPORT PT/AERO REF PT
$ --- MPC 10 FOR     SYMMETRIC BC'S FOR SUPORT POINT
$ --- MPC 11 FOR ANTISYMMETRIC BC'S FOR SUPORT POINT
$
$:MPC---SID-----G0------C0------A0------G-------C-------A-------
MPC      10      3315    3       -1.     99      3       1.             +MP10A
+MP10A             99    5        2.25
MPC      10      4028    3       -1.     99      3       1.             +MP10B
+MP10B             99    5      -18.5
MPC      10      4013     1      -1.     99       1      1.             +MP10C
+MP10C             99     5      35.007
$
$
MPC      11      3304    2       -1.     99      2       1.             +MP11A
+MP11A             99    4       29.273
MPC      11      3315    2       -1.     99      2       1.             +MP11B
+MP11B             99    4      -29.911
MPC      11      2159     6      -1.     99       6      1.
```

```
$
$ - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
$
$ --- WING2 SECTION
$ ---  SPARS PERPENDICULAR TO CENTERLINE
$
$
$ --- MPC'S BELOW CONNECT AILERON TO MAIN BOX
$ ---  3 HINGE POINTS    1 ACTUATOR AT INBOARD HINGE
$      GRID  BUTT LINE
$      1077    81.
$      1117   128.685
$      1157   194.366
$:MPC---SID-----G0------C0------A0------G-------C-------A-------        CONTINUE
MPC       55      1077    1       -1.      1075     1       1.
MPC       55      1077    2       -1.      1075     2       1.              +MP551
+MP551             1075    6       1.
MPC       55      1077    3       -1.      1075     3       1.              +MP552
+MP552             1075    5      -1.
$
MPC       55      1117    1       -1.      1115     1       1.
MPC       55      1117    3       -1.      1115     3       1.              +MP553
+MP553             1115    5      -1.
$
MPC       55      1118    1       -1.      1116     1       1.
$
MPC       55      1157    1       -1.      1155     1       1.
MPC       55      1157    3       -1.      1155     3       1.              +MP554
+MP554             1155    5      -1.
$
$
$ ALL GRIDS SPC'D IN ROTATIONAL DIRECTIONS WITH PERMANENT SPC'S
$  INCLUSION OF ROTATIONAL STIFFNESS MUST BE ALLOWED BY OVERIDES
$  ON RELEVANT GRID PS FIELDS
$:GRDSET ID-----CP------X1------X2 -----X3------CD------PS------SEID----
GRDSET                                                          456
$
$:GRID-- ID-----CP------X1------X2 -----X3------CD------PS------SEID----
$ --- GRID 99 IS THE REFERENCE GRID FOR AERO
$ --- GRID 99 IS THE SUPORT POINT FOR INERTIA RELIEF
$ --- GRID 99 IS CONNECTED TO THE STRUCTURE WITH MPC'S
$
GRID      99              490.     0.      10.             0
$
$ --- WING SKIN GRIDS
$ ---     ODD  LOWER SKIN
$ ---     EVEN UPPER SKIN
$
GRID     1001             423.603 44.347  6.745
GRID     1003             454.    40.958  5.881
GRID     1004             454.    40.958  14.266
GRID     1005             495.5   34.909  1.435
GRID     1006             495.5   34.909  19.45
GRID     1007             520.25  35.067  1.438
```

```
GRID    1008            520.25  35.067  18.616
GRID    1009            545.    34.909  1.44
GRID    1010            545.    34.909  17.783
GRID    1011            581.    34.909  1.44
GRID    1012            581.    34.909  16.578
GRID    1013            615.    34.909  1.44
GRID    1014            615.    34.909  15.44
GRID    1015            646.266 34.     8.563
GRID    1016            646.277 34.     11.611
GRID    1017            677.534 34.     8.881
$
GRID    1021            440.992 59.     5.463
GRID    1023            476.007 59.     3.912
GRID    1024            476.007 59.     11.264
GRID    1025            495.5   59.     3.963
GRID    1026            495.5   59.     12.761
GRID    1027            520.25  59.     4.03
GRID    1028            520.25  59.     13.769
GRID    1029            545.    59.     4.23
GRID    1030            545.    59.     13.987
GRID    1031            581.    59.     4.834
GRID    1032            581.    59.     13.24
GRID    1033            615.    59.     5.71
GRID    1034            615.    59.     11.406
GRID    1035            644.71  59.     6.238
GRID    1036            644.724 59.     9.128
GRID    1037            674.423 59.     6.542
$
GRID    1041            454.046 70.     4.5
GRID    1043            486.898 70.     3.045
GRID    1044            486.898 70.     9.944
GRID    1045            495.5   70.     3.064
GRID    1046            495.5   70.     10.757
GRID    1047            520.25  70.     3.125
GRID    1048            520.25  70.     12.123
GRID    1049            545.    70.     3.276
GRID    1050            545.    70.     12.537
GRID    1051            581.    70.     3.813
GRID    1052            581.    70.     11.925
GRID    1053            615.    70.     4.673
GRID    1054            615.    70.     10.23
$
GRID    1061            464.358 78.688  3.74
GRID    1065            495.5   78.688  2.361
GRID    1066            495.5   78.688  9.161
GRID    1067            520.25  79.844  2.325
GRID    1068            520.25  79.844  10.427
GRID    1069            545.    81.     2.336
GRID    1070            545.    81.     10.993
GRID    1071            581.    81.     2.801
GRID    1072            581.    81.     10.607
$:GRID-- ID-----CP------X1------X2 -----X3------CD------PS------SEID----
GRID    1073            615.    81.     3.635            0
GRID    1074            615.    81.     9.054
```

```
GRID    1075            633.    81.     4.045           0
GRID    1076            633.    81.     7.813           0
GRID    1077            634.    81.     4.045
GRID    1078            634.    81.     7.813
GRID    1079            671.562 81.     4.39
$
GRID    1081            494.019 103.68  1.554
GRID    1087            520.25  103.68  0.336
GRID    1088            520.25  103.68  5.899
GRID    1089            545.    103.68  0.449
GRID    1090            544.999 103.68  7.595
GRID    1091            581.    103.68  0.748
GRID    1092            581.    103.68  7.883
GRID    1093            615.    103.68  1.491
GRID    1094            615.    103.68  6.604
GRID    1095            635.    103.68  1.967
GRID    1096            635.    103.68  5.274
GRID    1097            636.    103.68  1.981
GRID    1098            636.    103.68  5.189
GRID    1099            668.863 103.68  2.362
$
GRID    1101            523.69  128.685 -0.634
GRID    1109            545.    128.685 -1.578
GRID    1110            545.    128.685 2.897
GRID    1111            581.    128.685 -1.443
GRID    1112            581.    128.685 4.59
GRID    1113            615.    128.685 -0.861
GRID    1114            615.    128.685 3.806
$:GRID-- ID-----CP------X1------X2 -----X3------CD------PS------SEID----
GRID    1115            637.206 128.685 -0.313          6
GRID    1116            637.206 128.685 2.474           6
GRID    1117            638.206 128.685 -0.313
GRID    1118            638.206 128.685 2.474
GRID    1119            665.752 128.685 0.023
$
GRID    1121            566.842 165.046 -3.815
GRID    1131            581.    165.046 -4.442
GRID    1132            581.    165.046 -1.469
GRID    1133            615.    165.046 -4.229
GRID    1134            615.    165.046 -0.43
GRID    1135            640.414 165.046 -3.646
GRID    1136            640.415 165.046 -1.608
GRID    1137            641.418 165.046 -3.622
GRID    1138            641.418 165.046 -1.682
GRID    1139            661.227 165.046 -3.379
$
GRID    1141            601.637 194.366 -6.38
GRID    1151            610.029 194.366 -6.752
GRID    1152            610.029 194.366 -4.99
GRID    1153            615.    194.366 -6.739
GRID    1154            615.    194.366 -4.615
$:GRID-- ID-----CP------X1------X2 -----X3------CD------PS------SEID----
GRID    1155            643.    194.366 -6.33           6
GRID    1156            643.    194.366 -4.934          6
```

```
GRID    1157            644.    194.366 -6.33
GRID    1158            644.    194.366 -4.934
GRID    1159            657.578 194.366 -6.122
$
$ --- MAIN LANDING GEAR (MLG)
$ --- MLG PICK UP  GRID POINTS FOR MASS AND LOAD APPLICATION
$
$:GRID-- ID-----CP------X1------X2 -----X3------CD------PS------SEID----
GRID    1701            565.     70.     3.574
GRID    1702            565.     70.    12.197
$
$:CBAR--EID-----PID-----GA------GB------X1,G0---X2------X3-------------
$
$ --- BARS BELOW PROVIDE ROTATIONAL STIFFNESS FOR MPC'S AT AILERON HINGES
$ ---  AILERON LEADING EDGE GRIDS  ARE OFFSET 1. INCH AFT OF CORRESPONDING
$ --    GRIDS ON MAIN TORQUE BOX.
$ ---  THE OFFSET ELIMINATES THE PROBLEMS OF COINCIDENT GRIDS IN AERO SPLINES
$ ---    BUT ALSO REQUIRES BENDING STIFFNESS TO REACT THE ECCENTRIC MOMENTS
$
CBAR      73      71    1073    1075    -1.     1.      0.
CBAR      75      71    1075    1076    -1.     1.      0.
CBAR     115     113    1115    1116    -1.     1.      0.
CBAR     155     113    1155    1156    -1.     1.      0.
$
$:QDMEM1 EID----PID-----G1------G2------G3------G4------THETA---ZOFFS---
$ --- QDMEMS FOR WING SKINS
$
$ --- MATL COORD SYSTEM REFERENCE IS 2 EXCEPT FOR LEADING EDGES WHICH HAS 45
$ --- LOCAL X DIRECTION FOR MATERIAL IS OUTBOARD, PERPENDICULAR TO CENTERLINE
$
$ --- QDMEM'S FASTER THAN QUAD4'S, PRIMARY LOAD IS TENSION/COMPRESSION,
$ --- LESS CRITICAL FOR SHEAR. PRIMARY SHEAR LOAD WOULD REQUIRE THE IMPROVED
$ --- SHEAR ACCURACY OF QUAD4'S.
$
$ --- LOWER SKINS  ODD NUMBERS STARTING AT 1001
$
CQDMEM1  1001    1001    1003    1023    1021    1001    45
CQDMEM1  1003    1001    1005    1025    1023    1003    2
CQDMEM1  1005    1001    1007    1027    1025    1005    2
CQDMEM1  1007    1001    1009    1029    1027    1007    2
CQDMEM1  1009    1001    1011    1031    1029    1009    2
CQDMEM1  1011    1001    1013    1033    1031    1011    2
CQDMEM1  1013    1001    1015    1035    1033    1013    2
CQDMEM1  1015    1001    1017    1037    1035    1015    2
$
CQDMEM1  1021    1001    1023    1043    1041    1021    45
CQDMEM1  1023    1001    1025    1045    1043    1023    2
CQDMEM1  1025    1001    1027    1047    1045    1025    2
CQDMEM1  1027    1001    1029    1049    1047    1027    2
CQDMEM1  1029    1001    1031    1051    1049    1029    2
CQDMEM1  1031    1001    1033    1053    1051    1031    2
$
CQDMEM1  1041    1001    1043    1065    1061    1041    45
CQDMEM1  1045    1001    1047    1067    1065    1045    2
```

```
CQDMEM1  1047   1001   1049   1069   1067   1047   2
CQDMEM1  1049   1001   1051   1071   1069   1049   2
CQDMEM1  1051   1001   1053   1073   1071   1051   2
$
CQDMEM1  1061   1001   1065   1087   1081   1061   45
CQDMEM1  1067   1001   1069   1089   1087   1067   2
CQDMEM1  1069   1001   1071   1091   1089   1069   2
CQDMEM1  1071   1001   1073   1093   1091   1071   2
CQDMEM1  1073   1001   1075   1095   1093   1073   2
CQDMEM1  1075   1001   1079   1099   1097   1077   2
$
CQDMEM1  1081   1001   1087   1109   1101   1081   45
CQDMEM1  1089   1001   1091   1111   1109   1089   2
CQDMEM1  1091   1001   1093   1113   1111   1091   2
CQDMEM1  1093   1001   1095   1115   1113   1093   2
CQDMEM1  1095   1001   1099   1119   1117   1097   2
$
CQDMEM1  1101   1001   1109   1131   1121   1101   45
CQDMEM1  1111   1001   1113   1133   1131   1111   2
CQDMEM1  1113   1001   1115   1135   1133   1113   2
CQDMEM1  1115   1001   1119   1139   1137   1117   2
$
CQDMEM1  1121   1001   1131   1151   1141   1121   45
CQDMEM1  1131   1001   1133   1153   1151   1131   2
CQDMEM1  1133   1001   1135   1155   1153   1133   2
CQDMEM1  1135   1001   1139   1159   1157   1137   2
$
$ --- UPPER SKINS  EVEN NUMBERS STARTING AT 1202
$
CQDMEM1  1202   1001   1004   1024   1021   1001   45
CQDMEM1  1204   1001   1006   1026   1024   1004   2
CQDMEM1  1206   1001   1008   1028   1026   1006   2
CQDMEM1  1208   1001   1010   1030   1028   1008   2
CQDMEM1  1210   1001   1012   1032   1030   1010   2
CQDMEM1  1212   1001   1014   1034   1032   1012   2
CQDMEM1  1214   1001   1016   1036   1034   1014   2
CQDMEM1  1216   1001   1017   1037   1036   1016   2
$
CQDMEM1  1222   1001   1024   1044   1041   1021   45
CQDMEM1  1224   1001   1026   1046   1044   1024   2
CQDMEM1  1226   1001   1028   1048   1046   1026   2
CQDMEM1  1228   1001   1030   1050   1048   1028   2
CQDMEM1  1230   1001   1032   1052   1050   1030   2
CQDMEM1  1232   1001   1034   1054   1052   1032   2
$
CQDMEM1  1242   1001   1044   1066   1061   1041   45
CQDMEM1  1246   1001   1048   1068   1066   1046   2
CQDMEM1  1248   1001   1050   1070   1068   1048   2
CQDMEM1  1250   1001   1052   1072   1070   1050   2
CQDMEM1  1252   1001   1054   1074   1072   1052   2
$
CQDMEM1  1262   1001   1066   1088   1081   1061   45
CQDMEM1  1268   1001   1070   1090   1088   1068   2
CQDMEM1  1270   1001   1072   1092   1090   1070   2
```

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CQDMEM1  1272     1001     1074     1094     1092     1072     2
CQDMEM1  1274     1001     1076     1096     1094     1074     2
CQDMEM1  1276     1001     1079     1099     1098     1078     2
$
CQDMEM1  1282     1001     1088     1110     1101     1081     45
CQDMEM1  1290     1001     1092     1112     1110     1090     2
CQDMEM1  1292     1001     1094     1114     1112     1092     2
CQDMEM1  1294     1001     1096     1116     1114     1094     2
CQDMEM1  1296     1001     1099     1119     1118     1098     2
$
CQDMEM1  1302     1001     1110     1132     1121     1101     45
CQDMEM1  1312     1001     1114     1134     1132     1112     2
CQDMEM1  1314     1001     1116     1136     1134     1114     2
CQDMEM1  1316     1001     1119     1139     1138     1118     2
$
CQDMEM1  1322     1001     1132     1152     1141     1121     45
CQDMEM1  1332     1001     1134     1154     1152     1132     2
CQDMEM1  1334     1001     1136     1156     1154     1134     2
CQDMEM1  1336     1001     1139     1159     1158     1138     2
$
$
$:CTRMEM-EID----PID-----G1------G2------G3------THETA---ZOFFS----------
$
$ --- LOWER WING SKIN
$
CTRMEM   1043     1001     1045     1065     1043     2
CTRMEM   1065     1001     1067     1087     1065     2
CTRMEM   1087     1001     1089     1109     1087     2
CTRMEM   1109     1001     1111     1131     1109     2
$
$ --- UPPER WING SKIN
$
CTRMEM   1244     1001     1046     1066     1044     2
CTRMEM   1266     1001     1068     1088     1066     2
CTRMEM   1288     1001     1090     1110     1088     2
CTRMEM   1310     1001     1112     1132     1110     2
$
$ --- RIBS/SPARS
$ --- PRIMARY SHEAR LOAD - QUAD4'S NECESSARY
$
$ --- RIBS  1500'S (NUMBERED FORE TO AFT -- ROOT TO TIP )
$ --- MATERIAL COORDINATE SYSTEM IS THE BASIC SYSTEM
$
CQUAD4   1502     1002     1003     1005     1006     1004     1
CQUAD4   1503     1002     1005     1007     1008     1006     1
CQUAD4   1504     1002     1007     1009     1010     1008     1
CQUAD4   1505     1002     1009     1011     1012     1010     1
CQUAD4   1506     1002     1011     1013     1014     1012     1
CQUAD4   1507     1002     1013     1015     1016     1014     1
$
CQUAD4   1512     1002     1023     1025     1026     1024     1
CQUAD4   1513     1002     1025     1027     1028     1026     1
CQUAD4   1514     1002     1027     1029     1030     1028     1
CQUAD4   1515     1002     1029     1031     1032     1030     1
```

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CQUAD4  1516    1002    1031    1033    1034    1032    1
CQUAD4  1517    1002    1033    1035    1036    1034    1
$
CQUAD4  1522    1002    1043    1045    1046    1044    1
$
CQUAD4  1532    1002    1065    1067    1068    1066    1
CQUAD4  1533    1002    1067    1069    1070    1068    1
CQUAD4  1534    1002    1069    1071    1072    1070    1
CQUAD4  1535    1002    1071    1073    1074    1072    1
CQUAD4  1536    1002    1073    1075    1076    1074    1
$
CQUAD4  1542    1002    1087    1089    1090    1088    1
CQUAD4  1543    1002    1089    1091    1092    1090    1
CQUAD4  1544    1002    1091    1093    1094    1092    1
CQUAD4  1545    1002    1093    1095    1096    1094    1
$
CQUAD4  1552    1002    1109    1111    1112    1110    1
CQUAD4  1553    1002    1111    1113    1114    1112    1
CQUAD4  1554    1002    1113    1115    1116    1114    1
$
CQUAD4  1562    1002    1131    1133    1134    1132    1
CQUAD4  1563    1002    1133    1135    1136    1134    1
$
CQUAD4  1572    1002    1151    1153    1154    1152    1
CQUAD4  1573    1002    1153    1155    1156    1154    1
$
$ --- SPARS  1600'S (ROOT TO TIP -- FORE TO AFT )
$ --- MATERIAL COORDINATE SYSTEM HAS LOCAL X OUTBOARD
$
$ --- LEADING EDGE SPAR
$
CQUAD4  1601    1002    1003    1023    1024    1004    2
CQUAD4  1602    1002    1023    1043    1044    1024    2
CQUAD4  1603    1002    1043    1065    1066    1044    2
CQUAD4  1604    1002    1065    1087    1088    1066    2
CQUAD4  1605    1002    1087    1109    1110    1088    2
CQUAD4  1606    1002    1109    1131    1132    1110    2
CQUAD4  1607    1002    1131    1151    1152    1132    2
$
$ --- INTERMEDIATE SPARS
$
CQUAD4  1611    1002    1005    1025    1026    1006    2
CQUAD4  1612    1002    1025    1045    1046    1026    2
CQUAD4  1613    1002    1045    1065    1066    1046    2
$
CQUAD4  1621    1002    1007    1027    1028    1008    2
CQUAD4  1622    1002    1027    1047    1048    1028    2
CQUAD4  1623    1002    1047    1067    1068    1048    2
CQUAD4  1624    1002    1067    1087    1088    1068    2
$
CQUAD4  1631    1002    1009    1029    1030    1010    2
CQUAD4  1632    1002    1029    1049    1050    1030    2
CQUAD4  1633    1002    1049    1069    1070    1050    2
CQUAD4  1634    1002    1069    1089    1090    1070    2
```

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CQUAD4   1635    1002    1089    1109    1110    1090    2
$
CQUAD4   1641    1002    1011    1031    1032    1012    2
CQUAD4   1642    1002    1031    1051    1052    1032    2
CQUAD4   1643    1002    1051    1071    1072    1052    2
CQUAD4   1644    1002    1071    1091    1092    1072    2
CQUAD4   1645    1002    1091    1111    1112    1092    2
CQUAD4   1646    1002    1111    1131    1132    1112    2
$
CQUAD4   1651    1002    1013    1033    1034    1014    2
CQUAD4   1652    1002    1033    1053    1054    1034    2
CQUAD4   1653    1002    1053    1073    1074    1054    2
CQUAD4   1654    1002    1073    1093    1094    1074    2
CQUAD4   1655    1002    1093    1113    1114    1094    2
CQUAD4   1656    1002    1113    1133    1134    1114    2
CQUAD4   1657    1002    1133    1153    1154    1134    2
$
$ --- AFT MOST SPAR ON TORQUE BOX
$
CQUAD4   1661    1002    1015    1035    1036    1016    2
CQUAD4   1664    1002    1075    1095    1096    1076    2
CQUAD4   1665    1002    1095    1115    1116    1096    2
CQUAD4   1666    1002    1115    1135    1136    1116    2
CQUAD4   1667    1002    1135    1155    1156    1136    2
$
$ - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
$ --- AILERON SPAR
$
CQUAD4   1674    1002    1077    1097    1098    1078    2
CQUAD4   1675    1002    1097    1117    1118    1098    2
CQUAD4   1676    1002    1117    1137    1138    1118    2
CQUAD4   1677    1002    1137    1157    1158    1138    2
$
$ - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
$ --- MLG STRUCTURE
$ --- MLG RIB
CQUAD4   1701    1002    1049    1701    1702    1050    1
CQUAD4   1702    1002    1701    1051    1052    1702    1
$
$:CROD--EID-----PID-----G1------G2------TMAX----
$
CROD     1751       1    1701    1029
CROD     1752       1    1702    1030
$
$ - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
$
$:CTRIA3-EID----PID-----G1------G2------G3------THETA---ZOFFS----------
$
$ --- RIB TRIANGLES AT LEADING AND TRAILING EDGES
$
CTRIA3   1501    1002    1001    1003    1004    1
CTRIA3   1508    1002    1015    1017    1016    1
$
CTRIA3   1511    1002    1021    1023    1024    1
```

```
CTRIA3   1518     1002     1035     1037     1036     1
$
CTRIA3   1531     1002     1061     1065     1066     1
CTRIA3   1537     1002     1077     1079     1078     1
$
CTRIA3   1541     1002     1081     1087     1088     1
CTRIA3   1546     1002     1097     1099     1098     1
$
CTRIA3   1551     1002     1101     1109     1110     1
CTRIA3   1555     1002     1117     1119     1118     1
$
CTRIA3   1561     1002     1121     1131     1132     1
CTRIA3   1564     1002     1137     1139     1138     1
$
CTRIA3   1571     1002     1141     1151     1152     1
CTRIA3   1574     1002     1157     1159     1158     1
$
$:CONM2-EID-----G-------CID-----M-------X1------X2------X3------   ------
$ --- CONM2'S FOR NON-STRUCTURAL MASSES IN WING
$ --- PRIMARILY FUEL
$
CONM2   10031   1003            .0633
CONM2   10051   1005            .1266
CONM2   10071   1007            .1266
CONM2   10091   1009            .1266
CONM2   10111   1011            .1266
CONM2   10131   1013            .0633
$
CONM2   10231   1023            .1266
CONM2   10251   1025            .2532
CONM2   10271   1027            .2532
CONM2   10291   1029            .2532
CONM2   10311   1031            .2532
CONM2   10331   1033            .1266
$
CONM2   10651   1065            .1266
CONM2   10671   1067            .2532
CONM2   10691   1069            .2532
CONM2   10711   1071            .2532
CONM2   10731   1073            .1266
$
CONM2   10871   1087            .1266
CONM2   10891   1089            .2532
CONM2   10911   1091            .2532
CONM2   10931   1093            .1266
$
CONM2   11091   1109            .0633
CONM2   11111   1111            .1266
CONM2   11131   1113            .0633
$
CONM2   11151   1115            .2085
CONM2   11351   1135            .2241
$
CONM2   17011   1701            .5894
```

```
$
$
$FORCE--SID-----G-------CID-----SF------FX------FY------FZ------
$
$ --- 89-6-5
$ ---  SCALED UP TO 13.5G'S FROM  12 AS IN ORIGINAL REVWING RUN
$
$ ---   FORCE ON 3138 GIVES CANARD/BODY LIFT ON CANARD MID-NODE
$ ---    SHOULD REDUCE PITCH MOMENT TO LOW VALUE - SIMULATED TRIM
$
FORCE    13      3138              1.1250    0.0      0.0  51100.
$
FORCE    13      1141              1.1250    0.0      0.0    318.9
FORCE    13      1151              1.1250    0.0      0.0   1642.6
FORCE    13      1153              1.1250    0.0      0.0   3304.6
FORCE    13      1155              1.1250    0.0      0.0   -356.7
FORCE    13      1157              1.1250    0.0      0.0   -805.3
FORCE    13      1159              1.1250    0.0      0.0   -361.3
FORCE    13      1121              1.1250    0.0      0.0    429.8
FORCE    13      1131              1.1250    0.0      0.0   4346.0
FORCE    13      1133              1.1250    0.0      0.0   6078.8
FORCE    13      1135              1.1250    0.0      0.0   2054.2
FORCE    13      1137              1.1250    0.0      0.0   1301.0
FORCE    13      1139              1.1250    0.0      0.0    498.5
FORCE    13      1101              1.1250    0.0      0.0    795.5
FORCE    13      1109              1.1250    0.0      0.0   6653.0
FORCE    13      1111              1.1250    0.0      0.0   7767.3
FORCE    13      1113              1.1250    0.0      0.0   2177.6
FORCE    13      1115              1.1250    0.0      0.0    -18.5
FORCE    13      1117              1.1250    0.0      0.0    303.6
FORCE    13      1119              1.1250    0.0      0.0     66.9
FORCE    13      1081              1.1250    0.0      0.0   1146.1
FORCE    13      1087              1.1250    0.0      0.0   6880.0
FORCE    13      1089              1.1250    0.0      0.0   9481.9
FORCE    13      1091              1.1250    0.0      0.0   4597.5
FORCE    13      1093              1.1250    0.0      0.0  -2107.4
FORCE    13      1095              1.1250    0.0      0.0  -1456.9
FORCE    13      1097              1.1250    0.0      0.0  -1510.8
FORCE    13      1099              1.1250    0.0      0.0   -571.8
FORCE    13      1061              1.1250    0.0      0.0    646.3
FORCE    13      1065              1.1250    0.0      0.0   3375.8
FORCE    13      1067              1.1250    0.0      0.0   3913.3
FORCE    13      1069              1.1250    0.0      0.0   3887.7
FORCE    13      1071              1.1250    0.0      0.0   1729.7
FORCE    13      1073              1.1250    0.0      0.0   -326.6
FORCE    13      1075              1.1250    0.0      0.0   -258.3
FORCE    13      1077              1.1250    0.0      0.0   -300.2
FORCE    13      1079              1.1250    0.0      0.0    -72.1
FORCE    13      1041              1.1250    0.0      0.0   -202.5
FORCE    13      1043              1.1250    0.0      0.0   -573.6
FORCE    13      1045              1.1250    0.0      0.0   -636.8
FORCE    13      1047              1.1250    0.0      0.0   -176.9
FORCE    13      1049              1.1250    0.0      0.0   1460.2
FORCE    13      1051              1.1250    0.0      0.0   2403.0
```

```
FORCE    13      1053                   1.1250    0.0      0.0    441.7
FORCE    13      1021                   1.1250    0.0      0.0   1119.4
FORCE    13      1023                   1.1250    0.0      0.0   4806.5
FORCE    13      1025                   1.1250    0.0      0.0   5431.8
FORCE    13      1027                   1.1250    0.0      0.0   5798.8
FORCE    13      1029                   1.1250    0.0      0.0   4671.7
FORCE    13      1031                   1.1250    0.0      0.0   1161.1
FORCE    13      1033                   1.1250    0.0      0.0  -1373.8
FORCE    13      1035                   1.1250    0.0      0.0  -1105.8
FORCE    13      1037                   1.1250    0.0      0.0    -61.2
FORCE    13      1001                   1.1250    0.0      0.0    264.2
FORCE    13      1003                   1.1250    0.0      0.0   1604.3
FORCE    13      1005                   1.1250    0.0      0.0   1704.2
FORCE    13      1007                   1.1250    0.0      0.0   1121.7
FORCE    13      1009                   1.1250    0.0      0.0   1032.7
FORCE    13      1011                   1.1250    0.0      0.0    695.5
FORCE    13      1013                   1.1250    0.0      0.0    340.1
FORCE    13      1015                   1.1250    0.0      0.0    258.9
FORCE    13      1017                   1.1250    0.0      0.0     63.2
$
$
$
$-------2-------3-------4-------5-------6-------7-------8-------9------
$ --- LOAD CASE 1000
$ ---  UNIT 10000 LIFT ON WING TIP
$
FORCE    1000    1153                   1.0000  0.0      0.0     10000.
$
$ --- LOAD CASE 20000
$ ---  19829 LB ON NOSE GEAR PICKUP (1/2 PLANE) 5.95G ULT NOSE IMPACT LAND
$
FORCE    20000   2057                   1.0000  0.0      0.0     19829.
$
$ --- LOAD CASE 28000
$ ---  28331 LB ON NOSE GEAR PICKUP (1/2 PLANE) 8.51G ULT NOSE IMPACT LAND
$
FORCE    28000   2057                   1.0000  0.0      0.0     28331.
$
$ --- LOAD CASE 74000
$ ---  73758 LB ON MAIN GEAR PICKUP (1/2 PLANE) 6.91G ULT MAIN IMPACT LAND
$
FORCE    74000   1701                   1.0000  0.0      0.0     73758.
$
$
$ - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
$ - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
$ - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
$
$ --- FORWARD FUSELAGE SECTION
$ --- GRIDS AND ELEMENTS 2000'S
$
$:MAT1--MID-----E-------G-------NU------RHO-----A-------TREF----GE------
$MAT1    2024    1.04E7          0.3     2.59-4
$
```

```
$:PBAR--PID-----MID-----A-------I1------I2------J-------NSM------------
$PBAR    2010    2023    0.      0.05     .05      .05
$PBAR    2710    2023    0.      0.5     2.5       .2
$
$:PSHELL-PID----MID1----T-------MID2----12I/T**3-MID3---TS/T----NSM-----
$
$PSHELL  1       2024    0.05
$
$ --- MPC BELOW ATTACH THE FORWARD FUSELAGE TO (COINCIDENT GRIDS)
$ --- THE MID FUSELAGE AT FUS STN 330 (FS330)
$
$:MPC---SID-----G0------C0------A0------G-------C-------A-------        CONTINUE
MPC      55      2241    1       -1.     3001    1       1.
$MPC      55      2241    2       -1.     3001    2       1. $ SPC'D DIRECTION
MPC      55      2241    3       -1.     3001    3       1.
$
MPC      55      2242    1       -1.     3002    1       1.
MPC      55      2242    2       -1.     3002    2       1.
MPC      55      2242    3       -1.     3002    3       1.
$
MPC      55      2243    1       -1.     3003    1       1.
MPC      55      2243    2       -1.     3003    2       1.
MPC      55      2243    3       -1.     3003    3       1.
$
MPC      55      2244    1       -1.     3004    1       1.
MPC      55      2244    2       -1.     3004    2       1.
MPC      55      2244    3       -1.     3004    3       1.
$
MPC      55      2245    1       -1.     3005    1       1.
MPC      55      2245    2       -1.     3005    2       1.
MPC      55      2245    3       -1.     3005    3       1.
$
MPC      55      2246    1       -1.     3006    1       1.
MPC      55      2246    2       -1.     3006    2       1.
MPC      55      2246    3       -1.     3006    3       1.
$
MPC      55      2247    1       -1.     3007    1       1.
MPC      55      2247    2       -1.     3007    2       1.
MPC      55      2247    3       -1.     3007    3       1.
$
MPC      55      2248    1       -1.     3008    1       1.
MPC      55      2248    2       -1.     3008    2       1.
MPC      55      2248    3       -1.     3008    3       1.
$
MPC      55      2249    1       -1.     3028    1       1.
$MPC      55      2249    2       -1.     3028    2       1. $ SPC'D DIRECTION
MPC      55      2249    3       -1.     3028    3       1.
$
MPC      55      2250    1       -1.     3027    1       1.
MPC      55      2250    2       -1.     3027    2       1.
MPC      55      2250    3       -1.     3027    3       1.
$
MPC      55      2251    1       -1.     3025    1       1.
MPC      55      2251    2       -1.     3025    2       1.
```

```
MPC     55      2251    3       -1.     3025    3       1.
$
$
$:GRID---ID-----CP------X1------X2 -----X3------CD------PS------SEID----
$
GRID    2001            175.    0.      -23.074
GRID    2002            175.    6.333   -22.455
GRID    2003            175.    11.946  -19.6
GRID    2004            175.    14.263  -16.082
GRID    2005            175.    15.297  -11.633
GRID    2006            175.    15.391  -7.058
GRID    2007            175.    13.642  -0.643
GRID    2008            175.    8.951   4.023
GRID    2009            175.    6.103   5.214
GRID    2010            175.    0.      6.048
GRID    2011            175.    0.      -16.082
GRID    2012            175.    6.5     -16.082
GRID    2013            175.    11.028  -16.082
GRID    2014            175.    0.      -11.633
GRID    2015            175.    6.5     -11.633
GRID    2016            175.    10.898  -11.633
GRID    2017            175.    0.      -7.058
GRID    2018            175.    6.4     -7.058
GRID    2019            175.    10.895  -7.058
GRID    2020            175.    0.      -0.643
GRID    2021            175.    6.3     -0.643
GRID    2022            175.    9.971   -0.643
$
$:GRID---ID-----CP------X1------X2 -----X3------CD------PS------SEID----
GRID    2031            188.25  0.      -23.05          0
GRID    2032            188.25  6.366   -22.409         0
GRID    2033            188.25  12.543  -19.6           0
GRID    2034            188.25  15.062  -15.921         0
GRID    2035            188.25  16.431  -11.227         0
GRID    2036            188.25  16.703  -6.308          0
GRID    2037            188.25  16.087  -0.839          0
GRID    2038            188.25  13.888  4.185           0
GRID    2039            188.25  11.03   6.865           0
GRID    2040            188.25  7.669   8.804           0
GRID    2041            188.25  0.      9.978           0
GRID    2042            188.25  0.      -11.367         0
GRID    2043            188.25  6.5     -11.367         0
GRID    2044            188.25  6.5     -15.922         0
GRID    2045            188.25  10.781  -15.921         0
$
GRID    2052            194.88  6.364   -22.321         0
GRID    2053            194.88  12.84   -19.6
GRID    2054            194.88  15.546  -15.879
$:GRID---ID-----CP------X1------X2 -----X3------CD------PS------SEID----
GRID    2055            194.88  0.      -11.231         0
GRID    2056            194.88  6.5     -11.233         0
GRID    2057            194.88  6.5     -15.841         0
GRID    2058            194.88  11.023  -15.86
$
```

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GRID    2062            201.5   6.362   -22.233         0
GRID    2063            201.5   13.138  -19.6
$:GRID---ID-----CP------X1------X2 -----X3------CD------PS------SEID----
GRID    2064            201.5   16.03   -15.837         0
GRID    2065            201.5   17.365  -10.791         0
GRID    2066            201.5   17.748  -5.571          0
GRID    2067            201.5   17.538  -0.678          0
GRID    2068            201.5   16.495  4.1             0
GRID    2069            201.5   13.108  9.707           0
GRID    2070            201.5   9.235   12.393          0
GRID    2071            201.5   0.      14.029          0
GRID    2072            201.5   0.      -11.1           0
GRID    2073            201.5   6.5     -11.1           0
GRID    2074            201.5   6.5     -15.76          0
GRID    2075            201.5   11.265  -15.799
$
GRID    2082            215.    6.335   -21.923         0
GRID    2083            215.    13.32   -19.6
GRID    2084            215.    16.671  -15.595         0
GRID    2085            215.    17.701  -10.676         0
GRID    2086            215.    18.569  -4.811          0
GRID    2087            215.    18.041  3.992           0
GRID    2088            215.    14.694  12.057          0
GRID    2089            215.    8.743   16.519          0
GRID    2090             210.    0.      16.667          0
GRID    2091            215.    0.      -10.831         0
GRID    2092            215.    6.5     -10.831         0
GRID    2093            215.    6.5     -15.595         0
GRID    2094            215.    11.586  -15.595         0
$
GRID    2102            228.4   6.296   -21.497
GRID    2103            228.4   13.148  -19.6
GRID    2104            228.4   16.958  -15.595
GRID    2105            228.4   18.038  -10.56
GRID    2106            228.4   18.861  -4.747
GRID    2107            228.4   19.036  3.672
$:GRID---ID-----CP------X1------X2 -----X3------CD------PS------SEID----
GRID    2108            228.4   15.882  14.57           0
GRID    2109            228.4   14.023  16.646
GRID    2110            228.4   6.5     16.646
GRID    2111            228.4   0.      16.646
GRID    2112            228.4   6.5     -15.595
GRID    2113            228.4   13.129  -15.595
GRID    2114            228.4   0.      -10.56
GRID    2115            228.4   6.5     -10.56
GRID    2116            228.4   13.119  -10.56
GRID    2117            228.4   0.      -4.747
GRID    2118            228.4   6.5     -4.747
GRID    2119            228.4   13.119  -4.747
GRID    2120            228.4   0.      3.672
GRID    2121            228.4   6.5     3.672
GRID    2122            228.4   13.119  3.672
GRID    2123            228.4   0.      10.159
GRID    2124            228.4   6.5     10.159
```

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GRID    2125            228.4   13.119  10.159
$
GRID    2132            245.    6.24    -20.823
GRID    2133            245.    12.987  -19.277
$:GRID---ID-----CP------X1------X2 -----X3------CD------PS------SEID----
GRID    2134            245.    17.04   -15.644          0
GRID    2135            245.    18.87   -10.5            0
GRID    2136            245.    19.531  -4.687           0
GRID    2137            245.    19.666  3.672            0
GRID    2138            245.    17.776  15.261           0
GRID    2139            245.    16.767  17.636           0
GRID    2140            245.    6.5     -15.595
GRID    2141            245.    12.3    -15.595
GRID    2142            245.    6.5     -4.668           0
GRID    2143            245.    13.119  -4.668           0
GRID    2144            245.    0.      3.672            0
GRID    2145            245.    6.5     3.672            0
$
GRID    2152            255.08  6.209   -20.395
GRID    2153            255.08  12.871  -19.02
$:GRID---ID-----CP------X1------X2 -----X3------CD------PS------SEID----
GRID    2154            255.08  17.02   -15.635          0
GRID    2155            255.08  18.705  -10.331          0
GRID    2156            255.08  19.441  -4.621           0
GRID    2157            255.08  19.865  3.675            0
GRID    2158            255.08  18.569  15.261           0
GRID    2159            255.08  17.162  19.38            0
GRID    2160            255.08  6.5     -15.595          0
GRID    2161            255.08  11.763  -15.595          0
GRID    2162            255.08  6.5     -4.621           0
GRID    2163            255.08  13.119  -4.621           0
GRID    2164            255.08  0.      3.672
GRID    2165            255.08  6.5     3.672
$
GRID    2171            268.75  0.      -20.068
GRID    2172            268.75  6.177   -19.874
GRID    2173            268.75  12.73   -18.683
GRID    2174            268.75  16.965  -15.598
$:GRID---ID-----CP------X1------X2 -----X3------CD------PS------SEID----
GRID    2175            268.75  19.738  -4.556           0
GRID    2176            268.75  19.99   3.672            0
GRID    2177            268.75  19.222  15.261           0
GRID    2178            268.75  17.372  21.527           0
GRID    2179            268.75  0.      -15.595
GRID    2180            268.75  6.5     -15.595
GRID    2181            268.75  12.815  -15.595
GRID    2182            268.75  0.      -4.556
GRID    2183            268.75  6.5     -4.556
GRID    2184            268.75  13.119  -4.556
$
GRID    2191            282.23  0.      -19.684
GRID    2192            282.23  6.499   -19.823
GRID    2193            282.23  12.537  -18.503
GRID    2194            282.23  16.926  -15.595
```

```
$:GRID---ID-----CP------X1------X2 -----X3------CD------PS------SEID----
GRID    2195            282.23  19.554  -6.824          0
GRID    2196            282.23  20.022  3.672           0
GRID    2197            282.23  19.578  15.261          0
GRID    2198            282.23  17.823  23.954          0
GRID    2199            282.23  0.      -15.595
GRID    2200            282.23  6.499   -15.595
GRID    2201            282.23  12.577  -15.595
$:GRID---ID-----CP------X1------X2 -----X3------CD------PS------SEID----
GRID    2202            282.23  0.      -6.815          0
GRID    2203            282.23  6.5     -6.812          0
GRID    2204            282.23  12.577  -6.818          0
GRID    2205            287.44  0.      3.611           0
GRID    2206            287.44  6.499   3.605           0
GRID    2207            287.44  12.577  3.599           0
GRID    2208            287.44  20.02   3.592
GRID    2209            293.25  0.      15.249          0
GRID    2210            293.25  6.499   15.243          0
GRID    2211            293.25  12.577  15.237          0
GRID    2212            293.25  19.745  15.231
GRID    2213            299.    0.      26.776          0
GRID    2214            299.    6.5     26.783          0
GRID    2215            299.    12.577  26.787          0
GRID    2216            299.    18.005  26.79           0
$
GRID    2221            305.    0.      -19.545         0
GRID    2222            305.    6.157   -19.399         0
GRID    2223            305.    12.584  -18.501         0
GRID    2224            305.    16.869  -15.595         0
GRID    2225            305.    19.367  -8.403          0
GRID    2226            305.    19.978  3.672           0
GRID    2227            305.    19.833  15.261          0
GRID    2228            305.    18.081  27.785          0
GRID    2229            305.    0.      27.773          0
GRID    2230            305.    6.507   27.777          0
GRID    2231            305.    12.584  27.781          0
$
GRID    2241            330.    0.      -19.873
GRID    2242            330.    7.959   -19.637
GRID    2243            330.    13.198  -18.835
GRID    2244            330.    18.214  -14.656
GRID    2245            330.    19.348  -10.
GRID    2246            330.    19.969  3.255
GRID    2247            330.    19.662  20.716
GRID    2248            330.    17.813  32.19
GRID    2249            330.    0.      36.612
GRID    2250            330.    6.194   35.639
GRID    2251            330.    9.064   33.658
$
$:CBAR--EID-----PID-----GA------GB------X1,G0---X2------X3-------------
$
$ --- BAR'S ARE FOR MATHEMATICAL STABILITY IN THE FORWARD FUSELAGE, UNDESIGNED.
$
$ --- WHEN THE COCKPIT PRESSURIZATION LOAD CASES ARE AVAILABLE
```

```
$ ---    THEN THESE SHOULD BECOME DESIGNED ELEMENTS.
$
CBAR    2701    2710    2108    2139    0.      0.      1.
CBAR    2702    2710    2139    2159    0.      0.      1.
CBAR    2703    2710    2159    2178    0.      0.      1.
CBAR    2704    2710    2178    2198    0.      0.      1.
CBAR    2705    2710    2198    2216    0.      0.      1.
CBAR    2706    2710    2216    2228    0.      0.      1.
CBAR    2711    2010    2031    2032    0.      1.      0.
CBAR    2712    2010    2032    2033    0.      1.      0.
CBAR    2713    2010    2033    2034    0.      1.      0.
CBAR    2714    2010    2034    2035    0.      1.      0.
CBAR    2715    2010    2035    2036    0.      1.      0.
CBAR    2716    2010    2036    2037    0.      1.      0.
CBAR    2717    2010    2037    2038    0.      1.      0.
CBAR    2718    2010    2038    2039    0.      1.      0.
CBAR    2719    2010    2039    2040    0.      1.      0.
CBAR    2720    2010    2040    2041    0.      1.      0.
CBAR    2721    2010    2042    2043    0.      0.      1.
CBAR    2722    2010    2043    2044    0.      1.      0.
CBAR    2723    2010    2032    2044    0.      1.      0.
CBAR    2724    2010    2044    2045    0.      0.      1.
CBAR    2725    2010    2045    2034    0.      0.      1.
CBAR    2731    2010    2055    2056    0.      0.      1.
CBAR    2732    2010    2056    2057    0.      1.      0.
CBAR    2733    2010    2057    2052    0.      1.      0.
CBAR    2744    2010    2064    2065    0.      1.      0.
CBAR    2745    2010    2065    2066    0.      1.      0.
CBAR    2746    2010    2066    2067    0.      1.      0.
CBAR    2747    2010    2067    2068    0.      1.      0.
CBAR    2748    2010    2068    2069    0.      1.      0.
CBAR    2749    2010    2069    2070    0.      1.      0.
CBAR    2750    2010    2070    2071    0.      1.      0.
CBAR    2751    2010    2072    2073    0.      0.      1.
CBAR    2752    2010    2073    2074    0.      1.      0.
CBAR    2753    2010    2074    2062    0.      1.      0.
CBAR    2764    2010    2084    2085    0.      1.      0.
CBAR    2765    2010    2085    2086    0.      1.      0.
CBAR    2766    2010    2086    2087    0.      1.      0.
CBAR    2767    2010    2087    2088    0.      1.      0.
CBAR    2768    2010    2088    2089    0.      1.      0.
CBAR    2769    2010    2089    2090    0.      1.      0.
CBAR    2771    2010    2091    2092    0.      0.      1.
CBAR    2772    2010    2092    2093    0.      1.      0.
CBAR    2773    2010    2093    2082    0.      1.      0.
CBAR    2774    2010    2093    2094    0.      0.      1.
CBAR    2775    2010    2094    2084    0.      0.      1.
CBAR    2783    2010    2134    2135    0.      1.      0.
CBAR    2784    2010    2135    2136    0.      1.      0.
CBAR    2785    2010    2136    2137    0.      1.      0.
CBAR    2786    2010    2137    2138    0.      1.      0.
CBAR    2787    2010    2138    2139    0.      1.      0.
CBAR    2791    2010    2144    2145    0.      0.      1.
CBAR    2792    2010    2145    2142    0.      1.      0.
```

```
CBAR    2794    2010    2142    2143    0.      0.      1.
CBAR    2795    2010    2143    2136    0.      0.      1.
CBAR    2803    2010    2154    2155    0.      1.      0.
CBAR    2804    2010    2155    2156    0.      1.      0.
CBAR    2805    2010    2156    2157    0.      1.      0.
CBAR    2806    2010    2157    2158    0.      1.      0.
CBAR    2807    2010    2158    2159    0.      1.      0.
CBAR    2814    2010    2162    2163    0.      0.      1.
CBAR    2815    2010    2163    2156    0.      0.      1.
CBAR    2816    2010    2160    2161    0.      0.      1.
CBAR    2817    2010    2161    2154    0.      0.      1.
CBAR    2825    2010    2175    2176    0.      1.      0.
CBAR    2826    2010    2176    2177    0.      1.      0.
CBAR    2827    2010    2177    2178    0.      1.      0.
CBAR    2845    2010    2195    2196    0.      1.      0.
CBAR    2846    2010    2196    2197    0.      1.      0.
CBAR    2847    2010    2197    2198    0.      1.      0.
CBAR    2861    2010    2221    2222    0.      1.      0.
CBAR    2862    2010    2222    2223    0.      1.      0.
CBAR    2863    2010    2223    2224    0.      1.      0.
CBAR    2864    2010    2224    2225    0.      1.      0.
CBAR    2865    2010    2225    2226    0.      1.      0.
CBAR    2866    2010    2226    2227    0.      1.      0.
CBAR    2867    2010    2227    2228    0.      1.      0.
CBAR    2868    2010    2228    2231    0.      0.      1.
CBAR    2869    2010    2231    2230    0.      0.      1.
CBAR    2870    2010    2230    2229    0.      0.      1.
CBAR    2881    2010    2202    2205    0.      1.      0.
CBAR    2882    2010    2205    2209    0.      1.      0.
CBAR    2883    2010    2209    2213    0.      1.      0.
CBAR    2884    2010    2206    2203    0.      1.      0.
CBAR    2885    2010    2210    2206    0.      1.      0.
CBAR    2886    2010    2214    2210    0.      1.      0.
CBAR    2887    2010    2207    2204    0.      1.      0.
CBAR    2888    2010    2211    2207    0.      1.      0.
CBAR    2889    2010    2215    2211    0.      1.      0.
CBAR    2890    2010    2213    2214    0.      0.      1.
CBAR    2891    2010    2214    2215    0.      0.      1.
$
$:CONROD-EID----G1------G2------MID-----A-------J-------C-------NSM-----
$:CROD--EID-----PID-----G1------G2------TMAX----
$
$ --- LOWER LONGERON FWD FUS.
$
CROD    2501       1    2003    2033
CROD    2502       1    2033    2053
CROD    2503       1    2053    2063
CROD    2504       1    2063    2083
CROD    2505       1    2083    2103
CROD    2506       1    2103    2133
CROD    2507       1    2133    2153
CROD    2508       1    2153    2173
CROD    2509       1    2173    2193
CROD    2510       1    2193    2223
```

```
CROD    2511    1       2223    2243
$
$ --- UPPER LONGERON FWD FUS.
$
CROD    2521    1       2008    2039
CROD    2522    1       2039    2069
CROD    2523    1       2069    2088
CROD    2524    1       2088    2108
CROD    2525    1       2108    2139
CROD    2526    1       2139    2159
CROD    2527    1       2159    2178
CROD    2528    1       2178    2198
CROD    2529    1       2198    2216
CROD    2530    1       2216    2228
CROD    2531    1       2228    2248
$
$:CQUAD4-EID----PID-----G1------G2------G3------G4------THETA---ZOFFS---
$
$ --- FORWARD FUSELAGE SKINS
$
CQUAD4  2001    1003    2031    2001    2002    2032    1
CQUAD4  2002    1003    2032    2002    2003    2033    1
CQUAD4  2003    1       2033    2003    2004    2034    1
CQUAD4  2004    1       2034    2004    2005    2035    1
CQUAD4  2005    1       2035    2005    2006    2036    1
CQUAD4  2006    1       2036    2006    2007    2037    1
CQUAD4  2007    1       2037    2007    2008    2038    1
CQUAD4  2009    1003    2039    2008    2009    2040    1
CQUAD4  2010    1003    2040    2009    2010    2041    1
$
CQUAD4  2022    1003    2052    2032    2033    2053    1
CQUAD4  2023    1       2053    2033    2034    2054    1
$
CQUAD4  2042    1003    2062    2052    2053    2063    1
CQUAD4  2043    1       2063    2053    2054    2064    1
CQUAD4  2044    1       2064    2054    2035    2065    1
CQUAD4  2045    1       2065    2035    2036    2066    1
CQUAD4  2046    1       2066    2036    2037    2067    1
CQUAD4  2047    1       2067    2037    2038    2068    1
CQUAD4  2048    1       2068    2038    2039    2069    1
CQUAD4  2049    1003    2069    2039    2040    2070    1
CQUAD4  2050    1003    2070    2040    2041    2071    1
$
CQUAD4  2062    1003    2082    2062    2063    2083    1
CQUAD4  2063    1       2083    2063    2064    2084    1
CQUAD4  2064    1       2084    2064    2065    2085    1
CQUAD4  2065    1       2085    2065    2066    2086    1
CQUAD4  2066    1       2086    2066    2067    2087    1
CQUAD4  2068    1       2087    2068    2069    2088    1
CQUAD4  2069    1003    2088    2069    2070    2089    1
CQUAD4  2070    1003    2089    2070    2071    2090    1
$
CQUAD4  2082    1003    2102    2082    2083    2103    1
CQUAD4  2083    1       2103    2083    2084    2104    1
```

```
CQUAD4  2084    1       2104    2084    2085    2105    1
CQUAD4  2085    1       2105    2085    2086    2106    1
CQUAD4  2086    1       2106    2086    2087    2107    1
CQUAD4  2087    1       2107    2087    2088    2108    1
CQUAD4  2088    1       2108    2088    2089    2109    1
CQUAD4  2090    1003    2089    2110    2111    2090    1
$
CQUAD4  2102    1003    2132    2102    2103    2133    1
CQUAD4  2103    1       2133    2103    2104    2134    1
CQUAD4  2104    1       2134    2104    2105    2135    1
CQUAD4  2105    1       2135    2105    2106    2136    1
CQUAD4  2106    1       2136    2106    2107    2137    1
CQUAD4  2107    1       2137    2107    2108    2138    1
CQUAD4  2108    1       2138    2108    2109    2139    1
$
CQUAD4  2112    1003    2152    2132    2133    2153    1
CQUAD4  2113    1       2153    2133    2134    2154    1
CQUAD4  2114    1       2154    2134    2135    2155    1
CQUAD4  2115    1       2155    2135    2136    2156    1
CQUAD4  2116    1       2156    2136    2137    2157    1
CQUAD4  2117    1       2157    2137    2138    2158    1
CQUAD4  2118    1       2158    2138    2139    2159    1
$
CQUAD4  2122    1003    2172    2152    2153    2173    1
CQUAD4  2123    1       2173    2153    2154    2174    1
CQUAD4  2124    1       2174    2154    2155    2175    1
CQUAD4  2126    1       2175    2156    2157    2176    1
CQUAD4  2127    1       2176    2157    2158    2177    1
CQUAD4  2128    1       2177    2158    2159    2178    1
$
CQUAD4  2131    1003    2191    2171    2172    2192    1
CQUAD4  2132    1003    2192    2172    2173    2193    1
CQUAD4  2133    1       2193    2173    2174    2194    1
CQUAD4  2134    1       2194    2174    2175    2195    1
CQUAD4  2135    1       2195    2175    2176    2196    1
CQUAD4  2136    1       2196    2176    2177    2197    1
CQUAD4  2137    1       2197    2177    2178    2198    1
$
CQUAD4  2146    1       2208    2196    2197    2212    1
CQUAD4  2147    1       2212    2197    2198    2216    1
$
CQUAD4  2151    1003    2221    2191    2192    2222    1
CQUAD4  2152    1003    2222    2192    2193    2223    1
CQUAD4  2153    1       2223    2193    2194    2224    1
CQUAD4  2154    1       2224    2194    2195    2225    1
CQUAD4  2155    1       2225    2195    2208    2226    1
CQUAD4  2156    1       2226    2208    2212    2227    1
CQUAD4  2157    1       2227    2212    2216    2228    1
$
CQUAD4  2161    1003    2241    2221    2222    2242    1
CQUAD4  2162    1003    2242    2222    2223    2243    1
CQUAD4  2163    1       2243    2223    2224    2244    1
CQUAD4  2164    1       2244    2224    2225    2245    1
CQUAD4  2165    1       2245    2225    2226    2246    1
```

```
CQUAD4  2166    1       2246    2226    2227    2247    1
CQUAD4  2167    1       2247    2227    2228    2248    1
$
CQUAD4  2171    1003    2229    2213    2214    2230    1
CQUAD4  2172    1003    2230    2214    2215    2231    1
CQUAD4  2173    1003    2231    2215    2216    2228    1
CQUAD4  2174    1003    2249    2229    2230    2250    1
CQUAD4  2175    1003    2250    2230    2231    2251    1
CQUAD4  2176    1003    2251    2231    2228    2248    1
$
$ --- BHD 175
$
CQUAD4  2201    1003    2001    2002    2012    2011    2
CQUAD4  2202    1003    2013    2012    2002    2003    2
CQUAD4  2204    1003    2011    2012    2015    2014    2
CQUAD4  2205    1003    2012    2013    2016    2015    2
CQUAD4  2206    1003    2013    2004    2005    2016    2
CQUAD4  2207    1003    2014    2015    2018    2017    2
CQUAD4  2208    1003    2015    2016    2019    2018    2
CQUAD4  2209    1003    2016    2005    2006    2019    2
CQUAD4  2210    1003    2017    2018    2021    2020    2
CQUAD4  2211    1003    2018    2019    2022    2021    2
CQUAD4  2212    1003    2019    2006    2007    2022    2
CQUAD4  2213    1003    2020    2021    2009    2010    2
CQUAD4  2214    1003    2021    2022    2008    2009    2
$
$ --- EQUIPMENT SHELF SUPPORTS
$
CQUAD4  2221    1003    2052    2053    2058    2057    2
CQUAD4  2223    1003    2062    2063    2075    2074    2
$
$ --- BHD 228
$
CQUAD4  2232    1003    2103    2102    2112    2113    2
CQUAD4  2235    1003    2113    2112    2115    2116    2
CQUAD4  2236    1003    2104    2113    2116    2105    2
CQUAD4  2237    1003    2115    2114    2117    2118    2
CQUAD4  2238    1003    2116    2115    2118    2119    2
CQUAD4  2239    1003    2105    2116    2119    2106    2
CQUAD4  2240    1003    2118    2117    2120    2121    2
CQUAD4  2241    1003    2119    2118    2121    2122    2
CQUAD4  2242    1003    2106    2119    2122    2107    2
CQUAD4  2243    1003    2121    2120    2123    2124    2
CQUAD4  2244    1003    2122    2121    2124    2125    2
CQUAD4  2245    1003    2107    2122    2125    2108    2
CQUAD4  2246    1003    2124    2123    2111    2110    2
CQUAD4  2247    1003    2125    2124    2110    2109    2
$
$ --- SHELF SUPPORT
$
CQUAD4  2252    1003    2132    2133    2141    2140    2
$
$ --- AFT NOSE WHEEL WELL WALL
$
```

```
CQUAD4  2261    1003    2171    2172    2180    2179    2
CQUAD4  2262    1003    2172    2173    2181    2180    2
CQUAD4  2264    1003    2179    2180    2183    2182    2
CQUAD4  2265    1003    2180    2181    2184    2183    2
CQUAD4  2266    1003    2181    2174    2175    2184    2
$
$ --- CANT BHD 286
$
CQUAD4  2271    1003    2191    2192    2200    2199    2
CQUAD4  2272    1003    2192    2193    2201    2200    2
CQUAD4  2274    1003    2199    2200    2203    2202    2
CQUAD4  2275    1003    2200    2201    2204    2203    2
CQUAD4  2276    1003    2201    2194    2195    2204    2
CQUAD4  2277    1003    2202    2203    2206    2205    2
CQUAD4  2278    1003    2203    2204    2207    2206    2
CQUAD4  2279    1003    2204    2195    2208    2207    2
CQUAD4  2280    1003    2205    2206    2210    2209    2
CQUAD4  2281    1003    2206    2207    2211    2210    2
CQUAD4  2282    1003    2207    2208    2212    2211    2
CQUAD4  2283    1003    2209    2210    2214    2213    2
CQUAD4  2284    1003    2210    2211    2215    2214    2
CQUAD4  2285    1003    2211    2212    2216    2215    2
$
$ --- EQUIPMENT SHELVES
$
CQUAD4  2301    1003    2044    2012    2013    2045    1
CQUAD4  2302    1003    2045    2013    2004    2034    1
CQUAD4  2303    1003    2057    2044    2045    2058    1
CQUAD4  2304    1003    2058    2045    2034    2054    1
CQUAD4  2305    1003    2074    2057    2058    2075    1
CQUAD4  2306    1003    2075    2058    2054    2064    1
CQUAD4  2307    1003    2093    2074    2075    2094    1
CQUAD4  2308    1003    2094    2075    2064    2084    1
CQUAD4  2309    1003    2112    2093    2094    2113    1
CQUAD4  2310    1003    2113    2094    2084    2104    1
CQUAD4  2311    1003    2112    2113    2141    2140    1
CQUAD4  2312    1003    2113    2104    2134    2141    1
CQUAD4  2313    1003    2160    2140    2141    2161    1
CQUAD4  2314    1003    2161    2141    2134    2154    1
CQUAD4  2315    1003    2180    2160    2161    2181    1
CQUAD4  2316    1003    2181    2161    2154    2174    1
CQUAD4  2317    1003    2200    2180    2181    2201    1
CQUAD4  2318    1003    2201    2181    2174    2194    1
$
$ --- COCKPIT FLOOR
$
CQUAD4  2321    1003    2142    2118    2119    2143    1
CQUAD4  2322    1003    2143    2119    2106    2136    1
CQUAD4  2323    1003    2162    2142    2143    2163    1
CQUAD4  2324    1003    2163    2143    2136    2156    1
CQUAD4  2325    1003    2183    2162    2163    2184    1
CQUAD4  2326    1003    2184    2163    2156    2175    1
CQUAD4  2327    1003    2202    2182    2183    2203    1
CQUAD4  2328    1003    2203    2183    2184    2204    1
```

```
CQUAD4  2329    1003    2204    2184    2175    2195    1
CQUAD4  2331    1003    2042    2014    2015    2043    1
CQUAD4  2332    1003    2055    2042    2043    2056    1
CQUAD4  2333    1003    2072    2055    2056    2073    1
CQUAD4  2334    1003    2091    2072    2073    2092    1
CQUAD4  2335    1003    2114    2091    2092    2115    1
CQUAD4  2336    1003    2121    2145    2144    2120    1
CQUAD4  2337    1003    2145    2165    2164    2144    1
CQUAD4  2338    1003    2165    2183    2182    2164    1
$
$ -- NOSE WHEEL WELL SIDE WALL
$
CQUAD4  2341    1003    2002    2032    2044    2012    1
CQUAD4  2342    1003    2012    2044    2043    2015    1
CQUAD4  2343    1003    2032    2052    2057    2044    1
CQUAD4  2344    1003    2044    2057    2056    2043    1
CQUAD4  2345    1003    2052    2062    2074    2057    1
CQUAD4  2346    1003    2057    2074    2073    2056    1
CQUAD4  2347    1003    2062    2082    2093    2074    1
CQUAD4  2348    1003    2074    2093    2092    2073    1
CQUAD4  2349    1003    2082    2102    2112    2093    1
CQUAD4  2350    1003    2093    2112    2115    2092    1
CQUAD4  2351    1003    2102    2132    2140    2112    1
CQUAD4  2352    1003    2112    2140    2142    2115    1
CQUAD4  2354    1003    2118    2142    2145    2121    1
CQUAD4  2355    1003    2160    2140    2132    2152    1
CQUAD4  2356    1003    2140    2160    2162    2142    1
CQUAD4  2357    1003    2142    2162    2165    2145    1
CQUAD4  2358    1003    2180    2160    2152    2172    1
CQUAD4  2359    1003    2160    2180    2183    2162    1
CQUAD4  2361    1003    2172    2192    2200    2180    1
$
$:CTRIA3-EID----PID-----G1------G2------G3------THETA---ZOFFS----------
$
$ --- FUSELAGE SKIN/BHDS/ ETC
$
CTRIA3  2008    1       2038    2008    2039    1
CTRIA3  2024    1       2054    2034    2035    1
CTRIA3  2067    1       2087    2067    2068    1
CTRIA3  2089    1003    2089    2109    2110    1
CTRIA3  2125    1       2156    2175    2155    1
CTRIA3  2145    1       2196    2208    2195    1
$
CTRIA3  2203    1003    2004    2013    2003    2
CTRIA3  2215    1003    2022    2007    2008    2
CTRIA3  2222    1003    2054    2058    2053    2
CTRIA3  2224    1003    2064    2075    2063    2
CTRIA3  2233    1003    2104    2103    2113    2
CTRIA3  2248    1003    2109    2108    2125    2
CTRIA3  2253    1003    2133    2134    2141    2
CTRIA3  2263    1003    2174    2181    2173    2
CTRIA3  2273    1003    2194    2201    2193    2
$
CTRIA3  2353    1003    2115    2142    2118    1
```

```
CTRIA3  2360    1003    2162    2183    2165    1
$
$:CONM2-EID-----G-------CID-----M-------X1------X2------X3------        ------
$
CONM2   20011   2001            .0177
CONM2   20021   2002            .0177
CONM2   20031   2003            .0177
CONM2   20041   2004            .0177
CONM2   20051   2005            .0177
CONM2   20061   2006            .0177
CONM2   20071   2007            .0177
CONM2   20081   2008            .0177
CONM2   20091   2009            .0177
$
CONM2   20571   2057            .0712
CONM2   21401   2140            .0842
CONM2   21651   2165            .1166
$
CONM2   20891   2089            .0311
CONM2   20901   2090            .0311
CONM2   21091   2109            .0311
CONM2   21391   2139            .0311
CONM2   21591   2159            .0311
CONM2   21781   2178            .0311
CONM2   21981   2198            .0311
CONM2   22161   2216            .0311
CONM2   22281   2228            .0311
CONM2   22481   2248            .0311
$
CONM2   21821   2182            .0993
CONM2   21831   2183            .0993
CONM2   21841   2184            .0993
$
CONM2   22021   2202            .0993
CONM2   22031   2203            .0993
CONM2   22041   2204            .0993
$
CONM2   22241   2224            .2652
CONM2   22251   2225            .2652
CONM2   22261   2226            .2652
$
CONM2   20751   2075            .2474
CONM2   21411   2141            .0518
CONM2   21801   2180            .2073
$
CONM2   20151   2015            .0766
CONM2   20211   2021            .0766
$
CONM2   20121   2012            .064
CONM2   20131   2013            .064
$
CONM2   20572   2057            .0319
CONM2   20581   2058            .0319
$
```

```
CONM2   20441   2044            .013
CONM2   20451   2045            .013
$
CONM2   21451   2145            .0421
CONM2   21652   2165            .0421
$
$:SPC1--SID-----C-------G1------G2------G3------G4------G5------G6------
$
SPC1    10      246     2114    2117    2120    2123    2111    2144
SPC1    10      246     2031    2042    2041    2055    2072    2071
SPC1    10      246     2001    2011    2014    2017    2020    2010
SPC1    10      246     2229    2221    2241    2249
SPC1    10      246     2091    2090
SPC1    10      246     2191    2199    2202    2205    2209    2213
SPC1    10      246     2164    2171    2179    2182
$
$ --- BHD'S MODELED AS  MEMBRANE ONLY REQUIRE FORE/AFT SPC'S
$
SPC1    10      1       2011    2016    2017    2018    2019    2020
SPC1    10      1       2021    2022
SPC1    10      1       2116    2117    2122    2123    2124    2125
SPC1    10      1       2179    2199
$
$ --- 3 DIR SPC'S BELOW WERE ELIMINATED BECAUSE STABILITY BARS WERE USED
$
$SPC1    10      3       2042    2055    2072    2091    2094    2143
$SPC1    10      3       2144    2161    2163
$SPC1    10      3       2221    2222
$SPC1    10      3       2229    2230    2231
$
$ - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
$ - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
$ - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
$
$ --- MID FUSEL SECTION
$
$ ---  PBAR BELOW IS FOR NONDESIGNED CANARD SPINDLE/TORQUE ARM PROPS
$
$:PBAR--PID-----MID-----A-------I1------I2------J-------NSM------------
$PBAR    3701    4340    0.5     2.5     2.5     5.
$
$ ---  PROD IS FOR LINK AT FWD SPAR TO FUS ATTACH
$
$:PROD--PID-----MID-----A-------J-------C-------NSM-----TMIN----
$PROD    3599    4340    .11
$
$ --- MPC BELOW CONNECT MID FUSELAGE TO AFT FUSELAGE AT FUS STN 495.5
$
$:MPC---SID-----G0------C0------A0------G-------C-------A-------        CONTINUE
MPC     55      3341    1       -1.     4001    1       1.
$MPC     55      3341    2       -1.     4001    2       1.$ SPC'D DIRECTION
MPC     55      3341    3       -1.     4001    3       1.
$
MPC     55      3342    1       -1.     4002    1       1.
```

```
MPC     55      3342    2       -1.     4002    2       1.
MPC     55      3342    3       -1.     4002    3       1.
$
MPC     55      3343    1       -1.     4003    1       1.
MPC     55      3343    2       -1.     4003    2       1.
MPC     55      3343    3       -1.     4003    3       1.
$
MPC     55      3344    1       -1.     4004    1       1.
MPC     55      3344    2       -1.     4004    2       1.
MPC     55      3344    3       -1.     4004    3       1.
$
MPC     55      3345    1       -1.     4005    1       1.
MPC     55      3345    2       -1.     4005    2       1.
MPC     55      3345    3       -1.     4005    3       1.
$
MPC     55      3346    1       -1.     4006    1       1.
MPC     55      3346    2       -1.     4006    2       1.
MPC     55      3346    3       -1.     4006    3       1.
$
MPC     55      3347    1       -1.     4007    1       1.
MPC     55      3347    2       -1.     4007    2       1.
MPC     55      3347    3       -1.     4007    3       1.
$
MPC     55      3348    1       -1.     4008    1       1.
MPC     55      3348    2       -1.     4008    2       1.
MPC     55      3348    3       -1.     4008    3       1.
$
MPC     55      3349    1       -1.     4009    1       1.
MPC     55      3349    2       -1.     4009    2       1.
MPC     55      3349    3       -1.     4009    3       1.
$
MPC     55      3350    1       -1.     4010    1       1.
MPC     55      3350    2       -1.     4010    2       1.
MPC     55      3350    3       -1.     4010    3       1.
$
MPC     55      3351    1       -1.     4011    1       1.
MPC     55      3351    2       -1.     4011    2       1.
MPC     55      3351    3       -1.     4011    3       1.
$
MPC     55      3352    1       -1.     4012    1       1.
MPC     55      3352    2       -1.     4012    2       1.
MPC     55      3352    3       -1.     4012    3       1.
$
MPC     55      3353    1       -1.     4013    1       1.
$MPC     55      3353    2       -1.     4013    2       1.$ SPC'D DIRECTION
MPC     55      3353    3       -1.     4013    3       1.
$
$:GRID---ID-----CP------X1------X2 -----X3------CD------PS------SEID----
$
$ --- BHD 330
$
GRID    3001            330.    0.      -19.873
GRID    3002            330.    7.959   -19.637
GRID    3003            330.    13.198  -18.835
```

```
GRID     3004          330.    18.214  -14.656
GRID     3005          330.    19.348  -10.
GRID     3006          330.    19.969  3.255
GRID     3007          330.    19.662  20.716
GRID     3008          330.    17.813  32.19
GRID     3009          330.    14.64   38.316
GRID     3010          330.    8.917   42.322
GRID     3011          330.    0.001   43.535
GRID     3012          330.    0.      -10.
GRID     3013          330.    7.833   -10.
GRID     3014          330.    13.59   -10.
GRID     3015          330.    0.      -2.196
GRID     3016          330.    7.705   -0.219
GRID     3017          330.    13.221  3.332
GRID     3018          330.    0.      5.609
GRID     3019          330.    7.577   9.563
GRID     3020          330.    10.458  17.649
GRID     3021          330.    15.127  18.618
GRID     3022          330.    8.655   24.407
GRID     3023          330.    13.02   28.781
GRID     3024          330.    3.489   29.
GRID     3025          330.    9.064   33.658
GRID     3026          330.    0.      29.69
GRID     3027          330.    6.194   35.639
GRID     3028          330.    0.      36.612
$
$ --- INLET
$
GRID     3032          323.15  22.169  -4.357
GRID     3033          322.581 22.169  -3.379
GRID     3034          316.972 22.169  6.26
GRID     3035          311.363 22.169  15.899
GRID     3036          310.409 22.169  17.537
$
GRID     3042          335.589 22.169  -5.849
GRID     3043          335.589 26.28   -5.849
GRID     3044          335.589 40.917  -5.849
GRID     3045          334.62  49.925  -4.184
GRID     3046          330.    51.88   3.754
GRID     3047          325.371 51.733  11.707
GRID     3048          321.175 48.767  18.917
GRID     3049          320.249 42.597  20.508
GRID     3050          320.013 26.297  20.912
GRID     3051          320.    22.169  20.936
GRID     3052          335.019 22.169  -4.871
GRID     3053          335.019 26.28   -4.871
GRID     3054          334.834 40.671  -4.551
GRID     3055          333.249 47.136  -1.828
GRID     3056          329.922 49.798  3.887
GRID     3057          325.51  49.702  11.469
GRID     3058          322.461 46.565  16.707
GRID     3059          321.298 42.048  18.705
GRID     3060          320.954 26.28   19.297
GRID     3061          320.954 22.169  19.297
```

```
GRID    3062            327.987 22.169  7.213
GRID    3063            327.987 26.28   7.213
$
GRID    3064            341.67  22.169  -6.578
GRID    3065            341.67  26.28   -6.578
GRID    3066            341.67  40.901  -6.578
GRID    3067            341.67  49.879  -4.63
GRID    3068            341.67  52.114  4.489
GRID    3069            341.67  51.977  15.93
GRID    3070            341.67  48.581  26.411
GRID    3071            341.67  42.597  28.058
GRID    3072            341.67  28.597  28.578
GRID    3073            341.67  22.169  28.612
GRID    3074            341.67  22.169  -4.871
GRID    3075            341.67  26.28   -4.871
GRID    3076            341.67  40.608  -4.518
GRID    3077            341.67  47.233  -1.767
GRID    3078            341.67  49.817  4.632
GRID    3079            341.67  48.754  14.23
GRID    3080            341.67  44.717  17.823
GRID    3081            341.67  41.084  18.873
GRID    3082            341.67  26.28   19.297
GRID    3083            341.67  22.169  19.297
GRID    3084            341.67  22.169  7.213
GRID    3085            341.67  26.28   7.213
$
GRID    3091            360.    0.      -20.698
GRID    3092            360.    8.773   -20.472
GRID    3093            360.    14.571  -19.75
GRID    3094            360.    19.941  -15.209
GRID    3095            360.    20.827  -10.
GRID    3096            360.    21.353  2.588
GRID    3097            360.    21.127  21.486
GRID    3098            360.    19.374  33.946
GRID    3099            360.    15.905  40.318
GRID    3100            360.    9.491   43.967
GRID    3101            360.    0.      44.927
GRID    3102            360.    0.      -10.
GRID    3103            360.    7.918   -10.
GRID    3104            360.    17.6    -10.
GRID    3105            360.    17.126  2.588
GRID    3106            360.    9.235   19.381
GRID    3107            360.    0.      19.362
GRID    3108            360.    0.      23.534
GRID    3109            360.    7.727   23.7
GRID    3110            360.    13.131  28.637
GRID    3111            360.    13.663  34.187
GRID    3112            360.    9.491   40.765
GRID    3113            360.    0.      41.242
GRID    3114            360.    0.      32.388
$
GRID    3115            365.    22.169  -8.076
GRID    3116            365.    26.747  -8.037
GRID    3117            365.    41.653  -7.585
```

```
GRID     3118            365.    50.26   -3.658
GRID     3119            365.    51.562  5.959
$:GRID---ID-----CP------X1------X2 -----X3------CD------PS------SEID----
GRID     3120            365.    51.309  18.027          0
GRID     3121            365.    47.979  29.396
GRID     3122            365.    42.597  31.927
GRID     3123            365.    28.597  32.924
GRID     3124            365.    22.169  32.988
GRID     3125            365.    22.169  -4.894
GRID     3126            365.    26.747  -4.894
GRID     3127            365.    41.123  -4.472
GRID     3128            365.    47.621  -1.285
GRID     3129            365.    49.792  5.993
GRID     3130            365.    47.985  15.391
GRID     3131            365.    43.863  18.217
GRID     3132            365.    40.711  18.99
$:GRID---ID-----CP------X1------X2 -----X3------CD------PS------SEID----
GRID     3133            365.    26.746  19.367          0
GRID     3134            365.    22.169  19.367
GRID     3135            365.    22.169  7.237
GRID     3136            365.    26.747  7.236
$
$ --- CANARD GRID POINT FOR MASS AND LOAD APPLICATION
$:GRID---ID-----CP------X1------X2 -----X3------CD------PS------SEID----
GRID     3138            369.    73.     18.0            0
$
GRID     3141            390.    0.      -21.523
GRID     3142            390.    9.587   -21.307
GRID     3143            390.    15.944  -20.664
GRID     3144            390.    22.242  -15.924
GRID     3145            390.    24.008  -8.242
GRID     3146            390.    42.577  -7.626
GRID     3147            390.    49.149  -1.75
GRID     3148            390.    49.713  7.535
$:GRID---ID-----CP------X1------X2 -----X3------CD------PS------SEID----
GRID     3149            390.    49.314  19.699          0
GRID     3150            390.    45.981  31.27
GRID     3151            390.    42.597  33.735
GRID     3152            390.    28.597  35.867
GRID     3153            390.    22.155  35.989
GRID     3154            390.    17.671  41.592
GRID     3155            390.    11.088  44.294
GRID     3156            390.    0.001   44.999
GRID     3157            390.    0.      -10.
GRID     3158            390.    8.003   -10.
GRID     3159            390.    16.005  -10.001
GRID     3160            390.    25.548  -5.282
GRID     3161            390.    40.903  -3.77
GRID     3162            390.    45.608  0.27
GRID     3163            390.    5.-4    5.998
GRID     3164            390.    7.806   6.431
GRID     3165            390.    15.611  6.864
GRID     3166            390.    23.416  7.297
GRID     3167            390.    25.549  7.534
```

GRID	3168	390.	46.998	7.538
GRID	3169	390.	0.001	20.237
GRID	3170	390.	7.609	20.237
GRID	3171	390.	15.216	20.237
GRID	3172	390.	22.824	20.237
GRID	3173	390.	25.549	20.35
GRID	3174	390.	38.969	19.485
GRID	3175	390.	40.802	18.878
GRID	3176	390.	44.797	15.988
GRID	3177	390.	0.001	32.618
GRID	3178	390.	5.351	35.681
GRID	3179	390.	6.39	31.408
GRID	3180	390.	11.512	28.378
GRID	3181	390.	17.111	30.392
GRID	3182	390.	19.131	35.989
GRID	3183	390.	15.627	40.668
GRID	3184	390.	11.433	41.884
GRID	3185	390.	6.813	39.828
$				
GRID	3191	420.	0.	-22.481
GRID	3192	420.	9.668	-22.341
GRID	3193	420.	19.284	-21.435
GRID	3194	420.	25.617	-16.28
GRID	3195	420.	27.47	-8.326
GRID	3196	420.	38.819	-7.65
GRID	3197	420.	45.679	0.
GRID	3198	420.	45.983	8.268
GRID	3199	420.	45.638	20.867
GRID	3200	420.	42.598	32.952
GRID	3201	420.	28.598	37.857
GRID	3202	420.	25.514	37.997
GRID	3203	420.	20.587	42.936
GRID	3204	420.	13.612	44.489
GRID	3205	420.	0.	45.
GRID	3206	420.	0.	-10.
GRID	3207	420.	8.371	-10.
GRID	3208	420.	16.741	-10.
GRID	3211	420.	16.741	-6.496
GRID	3212	420.	27.095	-5.7
GRID	3213	420.	32.507	-3.877
GRID	3214	420.	36.434	0.
GRID	3215	420.	38.628	8.729
GRID	3216	420.	37.09	15.492
GRID	3217	420.	34.583	19.478
GRID	3218	420.	26.397	22.332
GRID	3219	420.	16.741	25.86
GRID	3220	420.	16.741	8.265
GRID	3221	420.	9.751	26.138
GRID	3222	420.	4.847	29.739
GRID	3223	420.	0.	37.979
GRID	3224	420.	7.756	33.767
GRID	3225	420.	11.131	29.25
GRID	3226	420.	16.741	28.693
GRID	3227	420.	20.655	31.9

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GRID    3228            420.    21.379  36.908
GRID    3229            420.    18.535  41.093
GRID    3230            420.    13.612  42.262
GRID    3231            420.    8.812   39.305
$
GRID    3241            454.    0.      -23.395
GRID    3242            454.    10.972  -23.221
GRID    3243            454.    21.905  -22.004
GRID    3244            454.    28.409  -16.393
GRID    3245            454.    30.228  -7.998
GRID    3246            454.    40.391  0.
$GRID    1004            454.    40.958  14.266
GRID    3247            454.    40.958  9.26
GRID    3248            454.    40.601  22.045
GRID    3249            454.    37.266  34.194
GRID    3250            454.    26.862  39.03
GRID    3251            454.    21.471  42.972
GRID    3252            454.    14.871  44.356
GRID    3253            454.    0.      44.996
GRID    3254            454.    0.      -8.858
GRID    3255            454.    4.792   -8.858
GRID    3256            454.    12.76   -7.838
GRID    3257            454.    20.008  -4.563
GRID    3258            454.    24.976  1.546
GRID    3259            454.    26.465  9.363
GRID    3260            454.    24.903  17.175
GRID    3261            454.    19.949  23.32
GRID    3262            454.    12.743  26.678
GRID    3263            454.    4.742   27.701
GRID    3264            454.    0.      27.701
GRID    3265            454.    0.      8.85
GRID    3266            454.    4.742   8.85
GRID    3267            454.    0.      36.348
GRID    3268            454.    7.132   34.219
GRID    3269            454.    11.985  29.796
GRID    3270            454.    15.684  28.203
GRID    3271            454.    22.222  26.303
GRID    3272            454.    25.122  31.195
GRID    3273            454.    22.032  36.25
GRID    3274            454.    14.871  39.16
GRID    3275            454.    10.576  38.67
$
GRID    3291            474.75  0.      -23.767
GRID    3292            474.75  11.928  -23.614
GRID    3293            474.75  23.783  -22.468
GRID    3294            474.75  30.101  -16.131
GRID    3295            474.75  31.465  -6.9
GRID    3296            474.75  37.31   0.206
GRID    3297            474.75  38.033  9.837
GRID    3298            474.75  37.526  22.763
GRID    3299            474.75  34.055  35.085
GRID    3300            474.75  28.204  38.88
GRID    3301            474.75  22.085  42.988
GRID    3302            474.75  14.805  44.487
```

```
GRID    3303            474.75  0.      45.007
GRID    3304            474.75  0.      -19.273
GRID    3305            474.75  10.686  -18.746
GRID    3306            474.75  20.988  -16.614
GRID    3307            474.75  26.111  -6.237
GRID    3308            474.75  31.635  0.733
GRID    3309            474.75  32.796  9.828
GRID    3310            474.75  31.85   21.132
GRID    3311            474.75  27.858  31.538
GRID    3312            474.75  23.957  34.068
GRID    3313            474.75  17.458  38.142
GRID    3314            474.75  10.047  39.313
GRID    3315            474.75  0.      39.911
GRID    3316            474.75  0.      -10.284
GRID    3317            474.75  8.202   -9.011
GRID    3318            474.75  15.399  -4.906
GRID    3319            474.75  20.284  1.785
GRID    3320            474.75  22.323  9.809
GRID    3321            474.75  20.497  17.87
GRID    3322            474.75  15.463  24.443
GRID    3323            474.75  8.205   28.449
GRID    3324            474.75  0.      29.72
GRID    3325            474.75  0.      9.718
$
GRID    3341            495.5   0.      -23.913
GRID    3342            495.5   12.286  -23.8
GRID    3343            495.5   25.088  -22.556
GRID    3344            495.5   31.342  -14.809
GRID    3345            495.5   32.303  -4.502
GRID    3346            495.5   34.909  1.435
GRID    3347            495.5   34.909  9.993
GRID    3348            495.5   34.909  19.45
GRID    3349            495.5   32.87   32.96
GRID    3350            495.5   28.258  38.37
GRID    3351            495.5   21.755  42.668
GRID    3352            495.5   14.119  44.431
GRID    3353            495.5   0.      45.007
GRID    3354            498.5   0.      -11.179
GRID    3355            498.5   8.018   -9.392
GRID    3356            498.5   14.79   -4.794
GRID    3357            498.5   19.389  1.975
GRID    3358            498.5   21.179  9.994
GRID    3359            498.5   19.393  18.018
GRID    3360            498.5   14.789  24.795
GRID    3361            498.5   8.021   29.391
GRID    3362            498.5   0.      31.179
$
$:CONROD-EID----G1------G2------MID-----A-------J-------C-------NSM-----
$:CROD--EID-----PID-----G1------G2------TMAX----
$
CROD    3501    1       3003    3093
CROD    3502    1       3093    3143
CROD    3503    1       3143    3193
CROD    3504    1       3193    3243
```

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CROD    3505    1       3243    3293
CROD    3506    1       3293    3343
$
CROD    3511    1       3008    3098
CROD    3512    1       3098    3153
CROD    3513    1       3153    3202
CROD    3514    1       3202    3250
CROD    3515    1       3250    3300
CROD    3516    1       3300    3350
$
CROD    3521    1       3010    3100
CROD    3522    1       3100    3155
CROD    3523    1       3155    3204
CROD    3524    1       3204    3252
CROD    3525    1       3252    3302
CROD    3526    1       3302    3352
$
CROD    3551    1       3045    3067
CROD    3552    1       3067    3118
CROD    3553    1       3118    3147
CROD    3554    1       3147    3197
CROD    3555    1       3197    3246
CROD    3556    1       3246    3296
CROD    3557    1       3296    3346
$
CROD    3561    1       3048    3070
CROD    3562    1       3070    3121
CROD    3563    1       3121    3150
CROD    3564    1       3150    3200
CROD    3565    1       3200    3249
CROD    3566    1       3249    3299
CROD    3567    1       3299    3350
$
$ --- CROD   BELOW IS THE LINK AT THE FWD SPAR TO FUSELAGE ATTACHMENT
$
CROD    3599    3599    3247    1004
$
$:CBAR--EID-----PID-----GA------GB------X1,G0---X2------X3-------------
$
$ --- CANARD SPINDLE BARS (GRID 3138 IS SPINDLE TIP)
$
CBAR    3701    3701    3133    3120    0.      0.      1.
CBAR    3702    3701    3120    3138    0.      0.      1.
CBAR    3703    3701    3120    3149    0.      0.      1.
$
$:CQUAD4-EID----PID-----G1------G2------G3------G4------THETA---ZOFFS---
$
CQUAD4  3001    1003    3091    3001    3002    3092    1
CQUAD4  3002    1003    3092    3002    3003    3093    1
CQUAD4  3003    1       3093    3003    3004    3094    1
CQUAD4  3004    1       3094    3004    3005    3095    1
CQUAD4  3005    1       3095    3005    3006    3096    1
CQUAD4  3006    1       3096    3006    3007    3097    1
CQUAD4  3007    1       3097    3007    3008    3098    1
```

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CQUAD4  3008    1       3098    3008    3009    3099    1
CQUAD4  3009    1003    3099    3009    3010    3100    1
CQUAD4  3010    1003    3100    3010    3011    3101    1
$
CQUAD4  3021    1003    3141    3091    3092    3142    1
CQUAD4  3022    1003    3142    3092    3093    3143    1
CQUAD4  3023    1       3143    3093    3094    3144    1
CQUAD4  3024    1       3144    3094    3095    3145    1
CQUAD4  3025    1       3145    3095    3096    3166    1
CQUAD4  3026    1       3166    3096    3097    3172    1
CQUAD4  3027    1       3172    3097    3098    3153    1
CQUAD4  3028    1       3153    3098    3099    3154    1
CQUAD4  3029    1003    3154    3099    3100    3155    1
CQUAD4  3030    1003    3155    3100    3101    3156    1
$
CQUAD4  3041    1003    3191    3141    3142    3192    1
CQUAD4  3042    1003    3192    3142    3143    3193    1
CQUAD4  3043    1       3193    3143    3144    3194    1
CQUAD4  3044    1       3194    3144    3145    3195    1
CQUAD4  3045    1       3195    3145    3146    3196    1
CQUAD4  3046    1       3196    3146    3147    3197    1
CQUAD4  3047    1       3197    3147    3148    3198    1
CQUAD4  3048    1       3198    3148    3149    3199    1
CQUAD4  3049    1       3199    3149    3150    3200    1
CQUAD4  3051    1       3200    3151    3152    3201    1
CQUAD4  3052    1       3201    3152    3153    3202    1
CQUAD4  3053    1       3202    3153    3154    3203    1
CQUAD4  3054    1003    3203    3154    3155    3204    1
CQUAD4  3055    1003    3204    3155    3156    3205    1
$
CQUAD4  3061    1003    3241    3191    3192    3242    1
CQUAD4  3062    1003    3242    3192    3193    3243    1
CQUAD4  3063    1       3243    3193    3194    3244    1
CQUAD4  3064    1       3244    3194    3195    3245    1
CQUAD4  3066    1       3245    3196    3197    3246    1
CQUAD4  3067    1       3246    3197    3198    3247    1
CQUAD4  3068    1       3247    3198    3199    3248    1
CQUAD4  3069    1       3248    3199    3200    3249    1
CQUAD4  3070    1       3249    3200    3201    3250    1
CQUAD4  3072    1       3250    3202    3203    3251    1
CQUAD4  3073    1003    3251    3203    3204    3252    1
CQUAD4  3074    1003    3252    3204    3205    3253    1
$
CQUAD4  3081    1003    3291    3241    3242    3292    1
CQUAD4  3082    1003    3292    3242    3243    3293    1
CQUAD4  3083    1       3293    3243    3244    3294    1
CQUAD4  3084    1       3294    3244    3245    3295    1
CQUAD4  3085    1       3295    3245    3246    3296    1
CQUAD4  3086    1       3296    3246    3247    3297    1
CQUAD4  3087    1       3297    3247    3248    3298    1
CQUAD4  3088    1       3298    3248    3249    3299    1
CQUAD4  3089    1       3299    3249    3250    3300    1
CQUAD4  3090    1       3300    3250    3251    3301    1
CQUAD4  3091    1003    3301    3251    3252    3302    1
```

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CQUAD4  3092    1003    3302    3252    3253    3303    1
$
CQUAD4  3101    1003    3341    3291    3292    3342    1
CQUAD4  3102    1003    3342    3292    3293    3343    1
CQUAD4  3103    1       3343    3293    3294    3344    1
CQUAD4  3104    1       3344    3294    3295    3345    1
CQUAD4  3105    1       3345    3295    3296    3346    1
CQUAD4  3106    1       3346    3296    3297    3347    1
CQUAD4  3107    1       3347    3297    3298    3348    1
CQUAD4  3108    1       3348    3298    3299    3349    1
CQUAD4  3109    1       3349    3299    3300    3350    1
CQUAD4  3110    1       3350    3300    3301    3351    1
CQUAD4  3111    1003    3351    3301    3302    3352    1
CQUAD4  3112    1003    3352    3302    3303    3353    1
$
$ --- BHD 330
$
CQUAD4  3121    1003    3002    3001    3012    3013    2
CQUAD4  3122    1003    3003    3002    3013    3014    2
CQUAD4  3123    1003    3004    3003    3014    3005    2
CQUAD4  3124    1003    3013    3012    3015    3016    2
CQUAD4  3125    1003    3014    3013    3016    3017    2
CQUAD4  3126    1003    3005    3014    3017    3006    2
CQUAD4  3127    1003    3016    3015    3018    3019    2
CQUAD4  3129    1003    3020    3021    3017    3019    2
CQUAD4  3130    1003    3006    3017    3021    3007    2
CQUAD4  3131    1003    3021    3020    3022    3023    2
CQUAD4  3132    1003    3007    3021    3023    3008    2
CQUAD4  3133    1003    3024    3025    3023    3022    2
CQUAD4  3134    1003    3025    3009    3008    3023    2
CQUAD4  3136    1003    3025    3027    3010    3009    2
CQUAD4  3137    1003    3024    3026    3028    3027    2
CQUAD4  3138    1003    3027    3028    3011    3010    2
$
$ --- FRAME 360
$
CQUAD4  3141    1003    3091    3092    3103    3102    2
CQUAD4  3142    1003    3092    3093    3104    3103    2
CQUAD4  3143    1003    3093    3094    3095    3104    2
CQUAD4  3144    1003    3104    3095    3096    3105    2
CQUAD4  3145    1003    3105    3096    3097    3106    2
CQUAD4  3146    1003    3107    3106    3109    3108    2
CQUAD4  3147    1003    3106    3097    3110    3109    2
CQUAD4  3148    1003    3098    3111    3110    3097    2
CQUAD4  3149    1003    3099    3112    3111    3098    2
CQUAD4  3151    1003    3113    3112    3100    3101    2
$
$ --- BHD 390
$
CQUAD4  3161    1003    3141    3142    3158    3157    2
CQUAD4  3162    1003    3142    3143    3159    3158    2
CQUAD4  3163    1003    3145    3159    3143    3144    2
CQUAD4  3164    1003    3157    3158    3164    3163    2
CQUAD4  3165    1003    3158    3159    3165    3164    2
```

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CQUAD4  3166    1003    3159    3145    3166    3165    2
CQUAD4  3167    1003    3167    3166    3145    3160    2
CQUAD4  3168    1003    3145    3146    3161    3160    2
CQUAD4  3169    1003    3162    3161    3146    3147    2
CQUAD4  3170    1003    3148    3168    3162    3147    2
CQUAD4  3171    1003    3168    3148    3149    3176    2
CQUAD4  3172    1003    3175    3176    3149    3150    2
CQUAD4  3173    1003    3174    3175    3150    3151    2
CQUAD4  3174    1003    3173    3174    3151    3152    2
CQUAD4  3175    1003    3172    3173    3152    3153    2
CQUAD4  3176    1003    3163    3164    3170    3169    2
CQUAD4  3177    1003    3164    3165    3171    3170    2
CQUAD4  3178    1003    3165    3166    3172    3171    2
CQUAD4  3179    1003    3166    3167    3173    3172    2
CQUAD4  3180    1003    3169    3170    3180    3179    2
CQUAD4  3182    1003    3171    3172    3181    3180    2
CQUAD4  3183    1003    3153    3182    3181    3172    2
CQUAD4  3184    1003    3154    3183    3182    3153    2
CQUAD4  3185    1003    3154    3155    3184    3183    2
CQUAD4  3186    1003    3155    3156    3185    3184    2
CQUAD4  3187    1003    3185    3156    3177    3178    2
CQUAD4  3188    1003    3178    3177    3169    3179    2
$
$ --- FRAME 420
$
CQUAD4  3191    1003    3191    3192    3207    3206    2
CQUAD4  3192    1003    3192    3193    3208    3207    2
CQUAD4  3193    1003    3195    3208    3193    3194    2
CQUAD4  3194    1003    3208    3195    3212    3211    2
CQUAD4  3195    1003    3195    3196    3213    3212    2
CQUAD4  3196    1003    3197    3214    3213    3196    2
CQUAD4  3197    1003    3214    3197    3198    3215    2
CQUAD4  3198    1003    3215    3198    3199    3216    2
CQUAD4  3199    1003    3216    3199    3200    3217    2
CQUAD4  3200    1003    3218    3217    3200    3201    2
CQUAD4  3201    1003    3201    3202    3227    3218    2
CQUAD4  3203    1003    3229    3228    3202    3203    2
CQUAD4  3204    1003    3203    3204    3230    3229    2
CQUAD4  3205    1003    3204    3205    3231    3230    2
CQUAD4  3206    1003    3223    3224    3231    3205    2
CQUAD4  3208    1003    3222    3221    3225    3224    2
CQUAD4  3209    1003    3221    3219    3226    3225    2
CQUAD4  3210    1003    3219    3218    3227    3226    2
$
$ --- BHD 454
$
CQUAD4  3221    1003    3241    3242    3255    3254    2
CQUAD4  3222    1003    3242    3243    3256    3255    2
CQUAD4  3223    1003    3257    3256    3243    3244    2
CQUAD4  3225    1003    3246    3258    3257    3245    2
CQUAD4  3226    1003    3258    3246    3247    3259    2
CQUAD4  3227    1003    3259    3247    3248    3260    2
CQUAD4  3228    1003    3248    3271    3261    3260    2
CQUAD4  3229    1003    3271    3248    3249    3272    2
```

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CQUAD4  3230    1003    3249    3250    3273    3272    2
CQUAD4  3232    1003    3251    3252    3274    3273    2
CQUAD4  3233    1003    3275    3274    3252    3253    2
CQUAD4  3234    1003    3267    3268    3275    3253    2
CQUAD4  3235    1003    3264    3263    3268    3267    2
CQUAD4  3236    1003    3263    3262    3269    3268    2
CQUAD4  3238    1003    3271    3270    3262    3261    2
CQUAD4  3239    1003    3265    3266    3263    3264    2
CQUAD4  3240    1003    3254    3255    3266    3265    2
$
$ --- FRAME 475
$
CQUAD4  3251    1003    3305    3304    3291    3292    2
CQUAD4  3252    1003    3306    3305    3292    3293    2
CQUAD4  3254    1003    3306    3294    3295    3307    2
CQUAD4  3255    1003    3307    3295    3296    3308    2
CQUAD4  3256    1003    3308    3296    3297    3309    2
CQUAD4  3257    1003    3309    3297    3298    3310    2
CQUAD4  3258    1003    3310    3298    3299    3311    2
CQUAD4  3259    1003    3312    3311    3299    3300    2
CQUAD4  3260    1003    3313    3312    3300    3301    2
CQUAD4  3261    1003    3314    3313    3301    3302    2
CQUAD4  3262    1003    3315    3314    3302    3303    2
CQUAD4  3271    1003    3102    3012    3013    3103    1
CQUAD4  3272    1003    3103    3013    3014    3104    1
CQUAD4  3273    1003    3104    3014    3005    3095    1
CQUAD4  3274    1003    3157    3102    3103    3158    1
CQUAD4  3275    1003    3158    3103    3104    3159    1
CQUAD4  3276    1003    3159    3104    3095    3145    1
CQUAD4  3277    1003    3206    3157    3158    3207    1
CQUAD4  3279    1003    3207    3159    3145    3208    1
CQUAD4  3280    1003    3208    3145    3160    3211    1
CQUAD4  3281    1003    3254    3206    3207    3255    1
$
$ --- SHEAR CONNECTION FROM INLET TO MAIN FUSELAGE
$
CQUAD4  3299    1003    3096    3135    3134    3097    1
$
$ --- INLET OUTER MOLD LINE SKINS
$
CQUAD4  3303    1       3035    3061    3051    3036    1
CQUAD4  3304    1       3034    3062    3061    3035    1
CQUAD4  3305    1       3033    3052    3062    3034    1
CQUAD4  3306    1       3032    3042    3052    3033    1
$
CQUAD4  3311    1       3064    3042    3043    3065    1
CQUAD4  3312    1       3065    3043    3044    3066    1
CQUAD4  3313    1       3066    3044    3045    3067    1
CQUAD4  3314    1       3067    3045    3046    3068    1
CQUAD4  3315    1       3068    3046    3047    3069    1
CQUAD4  3316    1       3069    3047    3048    3070    1
CQUAD4  3317    1       3070    3048    3049    3071    1
CQUAD4  3318    1       3071    3049    3050    3072    1
CQUAD4  3319    1       3072    3050    3051    3073    1
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CQUAD4  3320  1     3061  3083  3073  3051  1
CQUAD4  3321  1     3062  3084  3083  3061  1
CQUAD4  3322  1     3052  3074  3084  3062  1
CQUAD4  3323  1     3074  3052  3042  3064  1
$
CQUAD4  3331  1     3115  3064  3065  3116  1
CQUAD4  3332  1     3116  3065  3066  3117  1
CQUAD4  3333  1     3117  3066  3067  3118  1
CQUAD4  3334  1     3118  3067  3068  3119  1
CQUAD4  3335  1     3119  3068  3069  3120  1
CQUAD4  3336  1     3120  3069  3070  3121  1
CQUAD4  3337  1     3121  3070  3071  3122  1
CQUAD4  3338  1     3122  3071  3072  3123  1
CQUAD4  3339  1     3123  3072  3073  3124  1
CQUAD4  3340  1     3124  3073  3083  3134  1
CQUAD4  3341  1     3134  3083  3084  3135  1
CQUAD4  3342  1     3135  3084  3074  3125  1
CQUAD4  3343  1     3125  3074  3064  3115  1
$
CQUAD4  3352  1     3145  3116  3117  3146  1
CQUAD4  3353  1     3146  3117  3118  3147  1
CQUAD4  3354  1     3147  3118  3119  3148  1
CQUAD4  3355  1     3148  3119  3120  3149  1
CQUAD4  3356  1     3149  3120  3121  3150  1
CQUAD4  3357  1     3150  3121  3122  3151  1
CQUAD4  3358  1     3151  3122  3123  3152  1
CQUAD4  3359  1     3152  3123  3124  3153  1
$
$ --- INLET FRAMES
$
CQUAD4  3361  1003  3035  3059  3049  3036  2
CQUAD4  3362  1003  3032  3044  3054  3033  2
CQUAD4  3363  1003  3042  3043  3053  3052  2
CQUAD4  3364  1003  3043  3044  3054  3053  2
CQUAD4  3365  1003  3044  3045  3055  3054  2
CQUAD4  3366  1003  3046  3056  3055  3045  2
CQUAD4  3367  1003  3056  3046  3047  3057  2
CQUAD4  3368  1003  3057  3047  3048  3058  2
CQUAD4  3369  1003  3048  3049  3059  3058  2
CQUAD4  3370  1003  3060  3059  3049  3050  2
CQUAD4  3371  1003  3061  3060  3050  3051  2
CQUAD4  3372  1003  3062  3063  3060  3061  2
CQUAD4  3373  1003  3052  3053  3063  3062  2
$
CQUAD4  3381  1003  3064  3065  3075  3074  2
CQUAD4  3382  1003  3065  3066  3076  3075  2
CQUAD4  3383  1003  3066  3067  3077  3076  2
CQUAD4  3384  1003  3068  3078  3077  3067  2
CQUAD4  3385  1003  3078  3068  3069  3079  2
CQUAD4  3386  1003  3079  3069  3070  3080  2
CQUAD4  3387  1003  3081  3080  3070  3071  2
CQUAD4  3388  1003  3082  3081  3071  3072  2
CQUAD4  3389  1003  3083  3082  3072  3073  2
CQUAD4  3390  1003  3084  3085  3082  3083  2
```

```
CQUAD4  3391    1003    3074    3075    3085    3084    2
$
CQUAD4  3401    1003    3115    3116    3126    3125    2
CQUAD4  3402    1003    3116    3117    3127    3126    2
CQUAD4  3403    1003    3117    3118    3128    3127    2
CQUAD4  3404    1003    3119    3129    3128    3118    2
CQUAD4  3405    1003    3129    3119    3120    3130    2
CQUAD4  3406    1003    3131    3130    3120    3121    2
CQUAD4  3407    1003    3132    3131    3121    3122    2
CQUAD4  3408    1003    3133    3132    3122    3123    2
CQUAD4  3409    1003    3134    3133    3123    3124    2
CQUAD4  3410    1003    3135    3136    3133    3134    2
CQUAD4  3411    1003    3125    3126    3136    3135    2
$
$ --- RALS DUCT TUNNEL SKIN
$
CQUAD4  3801    1       3108    3018    3019    3109    1
CQUAD4  3802    1       3109    3019    3020    3110    1
CQUAD4  3803    1       3110    3020    3022    3111    1
CQUAD4  3804    1       3111    3022    3024    3112    1
CQUAD4  3805    1       3112    3024    3026    3113    1
$
CQUAD4  3811    1       3179    3108    3109    3180    1
CQUAD4  3812    1       3180    3109    3110    3181    1
CQUAD4  3813    1       3181    3110    3111    3182    1
CQUAD4  3814    1       3182    3111    3112    3183    1
CQUAD4  3816    1       3184    3112    3113    3185    1
CQUAD4  3817    1       3185    3113    3114    3178    1
CQUAD4  3818    1       3178    3114    3108    3179    1
$
CQUAD4  3821    1       3225    3179    3180    3226    1
CQUAD4  3822    1       3226    3180    3181    3227    1
CQUAD4  3823    1       3227    3181    3182    3228    1
CQUAD4  3824    1       3228    3182    3183    3229    1
CQUAD4  3825    1       3229    3183    3184    3230    1
CQUAD4  3826    1       3230    3184    3185    3231    1
CQUAD4  3827    1       3231    3185    3178    3224    1
CQUAD4  3828    1       3224    3178    3179    3225    1
$
CQUAD4  3831    1       3269    3225    3226    3270    1
CQUAD4  3832    1       3270    3226    3227    3271    1
CQUAD4  3833    1       3271    3227    3228    3272    1
CQUAD4  3834    1       3272    3228    3229    3273    1
CQUAD4  3835    1       3273    3229    3230    3274    1
CQUAD4  3836    1       3274    3230    3231    3275    1
CQUAD4  3837    1       3275    3231    3224    3268    1
CQUAD4  3838    1       3268    3224    3225    3269    1
$
CQUAD4  3851    1       3153    3098    3111    3182    1
CQUAD4  3852    1       3184    3112    3100    3155    1
CQUAD4  3853    1       3230    3184    3155    3204    1
CQUAD4  3854    1       3204    3252    3274    3230    1
$
$ --- INLET DUCT INNER SKIN
```

```
$
CQUAD4   3902   1   3034   3063   3060   3035   1
CQUAD4   3903   1   3033   3053   3063   3034   1
$
CQUAD4   3911   1   3075   3053   3054   3076   1
CQUAD4   3912   1   3076   3054   3055   3077   1
CQUAD4   3913   1   3077   3055   3056   3078   1
CQUAD4   3914   1   3078   3056   3057   3079   1
CQUAD4   3915   1   3079   3057   3058   3080   1
CQUAD4   3916   1   3080   3058   3059   3081   1
CQUAD4   3917   1   3081   3059   3060   3082   1
CQUAD4   3918   1   3063   3085   3082   3060   1
CQUAD4   3919   1   3053   3075   3085   3063   1
$
CQUAD4   3921   1   3126   3075   3076   3127   1
CQUAD4   3922   1   3127   3076   3077   3128   1
CQUAD4   3923   1   3128   3077   3078   3129   1
CQUAD4   3924   1   3129   3078   3079   3130   1
CQUAD4   3925   1   3130   3079   3080   3131   1
CQUAD4   3926   1   3131   3080   3081   3132   1
CQUAD4   3927   1   3132   3081   3082   3133   1
CQUAD4   3928   1   3133   3082   3085   3136   1
CQUAD4   3929   1   3136   3085   3075   3126   1
$
CQUAD4   3931   1   3160   3126   3127   3161   1
CQUAD4   3932   1   3161   3127   3128   3162   1
CQUAD4   3933   1   3162   3128   3129   3168   1
CQUAD4   3934   1   3168   3129   3130   3176   1
CQUAD4   3935   1   3176   3130   3131   3175   1
CQUAD4   3936   1   3175   3131   3132   3174   1
CQUAD4   3937   1   3174   3132   3133   3173   1
CQUAD4   3938   1   3173   3133   3136   3167   1
CQUAD4   3939   1   3167   3136   3126   3160   1
$
CQUAD4   3941   1   3211   3160   3161   3212   1
CQUAD4   3943   1   3213   3161   3162   3214   1
CQUAD4   3944   1   3214   3162   3168   3215   1
CQUAD4   3945   1   3215   3168   3176   3216   1
CQUAD4   3946   1   3216   3176   3175   3217   1
CQUAD4   3948   1   3217   3174   3173   3218   1
CQUAD4   3950   1   3220   3167   3173   3219   1
CQUAD4   3951   1   3211   3160   3167   3220   1
$
CQUAD4   3961   1   3255   3211   3212   3256   1
CQUAD4   3962   1   3256   3212   3213   3257   1
CQUAD4   3963   1   3257   3213   3214   3258   1
CQUAD4   3964   1   3258   3214   3215   3259   1
CQUAD4   3965   1   3259   3215   3216   3260   1
CQUAD4   3966   1   3260   3216   3217   3261   1
CQUAD4   3967   1   3261   3217   3218   3262   1
CQUAD4   3968   1   3262   3218   3219   3263   1
CQUAD4   3969   1   3266   3220   3219   3263   1
CQUAD4   3970   1   3255   3211   3220   3266   1
$
```

```
CQUAD4  3971    1       3316    3255    3256    3317    1
CQUAD4  3972    1       3317    3256    3257    3318    1
CQUAD4  3973    1       3318    3257    3258    3319    1
CQUAD4  3974    1       3319    3258    3259    3320    1
CQUAD4  3975    1       3320    3259    3260    3321    1
CQUAD4  3976    1       3321    3260    3261    3322    1
CQUAD4  3977    1       3322    3261    3262    3323    1
CQUAD4  3978    1       3323    3262    3263    3324    1
CQUAD4  3979    1       3324    3263    3266    3325    1
CQUAD4  3980    1       3325    3266    3255    3316    1
$
CQUAD4  3981    1       3354    3316    3317    3355    1
CQUAD4  3982    1       3355    3317    3318    3356    1
CQUAD4  3983    1       3356    3318    3319    3357    1
CQUAD4  3984    1       3357    3319    3320    3358    1
CQUAD4  3985    1       3358    3320    3321    3359    1
CQUAD4  3986    1       3359    3321    3322    3360    1
CQUAD4  3987    1       3360    3322    3323    3361    1
CQUAD4  3988    1       3361    3323    3324    3362    1
$
$:CTRIA3-EID----PID-----G1------G2------G3------THETA---ZOFFS----------
$
CTRIA3  3050    1       3200    3150    3151    1
CTRIA3  3065    1       3245    3195    3196    1
CTRIA3  3071    1       3250    3201    3202    1
$
CTRIA3  3128    1003    3017    3016    3019    2
CTRIA3  3135    1003    3027    3025    3024    2
CTRIA3  3150    1003    3112    3099    3100    2
CTRIA3  3181    1003    3170    3171    3180    2
CTRIA3  3202    1003    3202    3228    3227    2
CTRIA3  3207    1003    3224    3223    3222    2
CTRIA3  3224    1003    3245    3257    3244    2
CTRIA3  3231    1003    3250    3251    3273    2
CTRIA3  3237    1003    3270    3269    3262    2
CTRIA3  3253    1003    3294    3306    3293    2
$
CTRIA3  3278    1003    3207    3158    3159    1
CTRIA3  3282    1003    3255    3207    3208    1
CTRIA3  3283    1003    3255    3208    3211    1
$
CTRIA3  3301    1       3036    3050    3049    1
CTRIA3  3302    1       3036    3051    3050    1
CTRIA3  3307    1       3042    3032    3043    1
CTRIA3  3308    1       3043    3032    3044    1
CTRIA3  3351    1       3145    3115    3116    1
$
CTRIA3  3815    1       3183    3112    3184    1
$
CTRIA3  3901    1       3035    3060    3059    1
CTRIA3  3904    1       3053    3033    3054    1
CTRIA3  3942    1       3212    3161    3213    1
CTRIA3  3947    1       3217    3175    3174    1
CTRIA3  3949    1       3218    3173    3219    1
```

```
$
$:CONM2-EID-----G-------CID-----M-------X1------X2------X3------   ------
$
CONM2   30181   3018            .0172
CONM2   30201   3020            .0172
CONM2   30261   3026            .0172
$
CONM2   31081   3108            .0172
CONM2   31101   3110            .0172
CONM2   31131   3113            .0172
$
CONM2   31791   3179            .0172
CONM2   31811   3181            .0172
CONM2   31841   3184            .0172
$
CONM2   32251   3225            .0172
CONM2   32271   3227            .0172
CONM2   32301   3230            .0172
$
CONM2   32681   3268            .0172
CONM2   32721   3272            .0172
CONM2   32741   3274            .0172
$
CONM2   31381   3138            .4132
CONM2   31321   3132            .2409
CONM2   32171   3217            .6528
$
CONM2   30911   3091            .4786
CONM2   30921   3092            .4786
$
CONM2   32911   3291            .4786
CONM2   32921   3292            .4786
$
CONM2   32701   3270            .2902
CONM2   30131   3013            .2254
$
CONM2   31911   3191            .0256
CONM2   33411   3341            .0456
$
CONM2   30121   3012            .2062
CONM2   30132   3013            .2062
CONM2   30141   3014            .2062
CONM2   30051   3005            .2062
$
CONM2   31021   3102            .4434
CONM2   31032   3103            .4434
CONM2   31041   3104            .4434
CONM2   30951   3095            .4434
$
CONM2   31571   3157            .5133
CONM2   31582   3158            .5133
CONM2   31591   3159            .5133
CONM2   31451   3145            .5133
$
```

```
CONM2   31621   3162            .0526
CONM2   31471   3147            .0526
$
CONM2   32061   3206            .5075
CONM2   32071   3207            .5075
CONM2   32081   3208            .5075
$
CONM2   32141   3214            .2238
CONM2   31971   3197            .2238
$
CONM2   32541   3254            .1201
CONM2   32551   3255            .1201
$
CONM2   32581   3258            .2014
CONM2   32461   3246            .2014
$
$:SPC1--SID-----C-------G1------G2------G3------G4------G5------G6------
$
SPC1    10      246     3001    3012    3015    3018    3026    3028
SPC1    10      246     3011    3042    3036    3049    3063    3062
SPC1    10      246     3091    3102    3107    3108    3114    3113
SPC1    10      246     3101    3094    3121
SPC1    10      246     3141    3157    3163    3169    3177    3156
SPC1    10      246     3191    3206    3223    3205    3174
SPC1    10      246     3241    3254    3265    3264    3267    3253
SPC1    10      246     3291    3304    3316    3325    3324    3315
SPC1    10      246     3303    3341    3354    3362    3353
$
$ --- GRIDS FIXED IN FORE/AFT DIRECTION DUE TO MEMBRANE ONLY STIFFNESS
$ ---    OF BULKHEADS AND FRAMES
$
SPC1    10      1       3015    3016    3017    3021    3023
SPC1    10      1       3105    3106    3107
SPC1    10      1       3163    3164    3165    3169    3170    3171
SPC1    10      1       3177    3221    3222    3223
SPC1    10      1       3264    3265    3267
SPC1    10      1       3304    3305    3306    3307    3308    3309
SPC1    10      1       3310    3311    3312    3313    3314    3315
$
$ - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
$
$ --- AFT FUSEL SECTION
$
$ ---  PBAR BELOW IS FOR NONDESIGNED FWD ENGINE MOUNT
$
$:PBAR--PID-----MID-----A-------I1------I2------J-------NSM------------
$PBAR     4655    4340    0.3     1.      1.      .1
$
$ --- PROD BELOW IS FOR THE ROD ABOVE THE CUTOUT IN BHD 495
$
$:PROD--PID-----MID-----A-------J-------C-------NSM-----TMIN----
$PROD     4114    2024    .5                              .15
$
$
```

```
$ --- MPC BELOW: CONNECT AFT BODY TO WING
$ ---            ( ALL LUGS HAVE VERTICAL AND LATERAL FORCE  +
$ ---              DRAG LOAD AT LWR STA 495.5 ONLY )
$
$:MPC---SID-----G0------C0------A0------G-------C-------A-------        CONTINUE
$ --- STA 495.5
MPC     55      1005    1       -1.     4006    1       1.
MPC     55      1005    2       -1.     4006    2       1.
MPC     55      1005    3       -1.     4006    3       1.
$
MPC     55      1006    2       -1.     4008    2       1.
MPC     55      1006    3       -1.     4008    3       1.
$
$ --- STA 545.
MPC     55      1009    2       -1.     4066    2       1.
MPC     55      1009    3       -1.     4066    3       1.
$
MPC     55      1010    2       -1.     4068    2       1.
MPC     55      1010    3       -1.     4068    3       1.
$
$ --- STA 581.
MPC     55      1011    2       -1.     4096    2       1.
MPC     55      1011    3       -1.     4096    3       1.
$
MPC     55      1012    2       -1.     4098    2       1.
MPC     55      1012    3       -1.     4098    3       1.
$
$ --- STA 615.
MPC     55      1013    2       -1.     4126    2       1.
MPC     55      1013    3       -1.     4126    3       1.
$
MPC     55      1014    2       -1.     4128    2       1.
MPC     55      1014    3       -1.     4128    3       1.
$
$:GRID---ID-----CP------X1------X2 -----X3------CD------PS------SEID----
GRID    4001            495.5   0.      -23.913
GRID    4002            495.5   12.286  -23.8
GRID    4003            495.5   25.088  -22.556
GRID    4004            495.5   31.342  -14.809
GRID    4005            495.5   32.303  -4.502
GRID    4006            495.5   34.909  1.435
GRID    4007            495.5   34.909  9.993
GRID    4008            495.5   34.909  19.45
GRID    4009            495.5   32.87   32.96
GRID    4010            495.5   28.258  38.37
GRID    4011            495.5   21.755  42.668
GRID    4012            495.5   14.119  44.431
GRID    4013            495.5   0.      45.007
GRID    4014            495.5   0.      -17.692
GRID    4015            495.5   12.287  -17.636
GRID    4016            495.5   20.859  -14.966
GRID    4017            495.5   0.      -11.472
GRID    4018            495.5   12.287  -11.472
GRID    4019            495.5   16.631  -7.376
```

```
GRID    4020            495.5   23.361  0.966
GRID    4021            495.5   24.749  5.712
GRID    4022            495.5   25.188  10.14
GRID    4023            495.5   25.322  19.59
GRID    4024            495.5   25.152  27.613
GRID    4025            495.5   22.673  32.751
GRID    4026            495.5   18.141  36.633
GRID    4027            495.5   13.899  38.607
GRID    4028            495.5   0.      38.807
$
GRID    4031            520.25  0.      -23.725
GRID    4032            520.25  13.252  -23.606
GRID    4033            520.25  26.109  -22.345
GRID    4034            520.25  31.476  -14.809
GRID    4035            520.25  32.52   -5.861
GRID    4036            520.25  34.923  1.438
GRID    4037            520.25  34.995  9.993
GRID    4038            520.25  35.067  18.616
GRID    4039            520.25  31.614  30.899
GRID    4040            520.25  28.46   37.22
GRID    4041            520.25  20.871  42.381
GRID    4042            520.25  13.29   44.14
GRID    4043            520.25  0.      44.788
GRID    4044            520.25  0.      -19.73
GRID    4045            520.25  13.25   -19.61
GRID    4046            520.25  25.11   -18.05
GRID    4047            520.25  27.48   -14.81
GRID    4048            520.25  28.81    -5.852
GRID    4049            520.25  29.15    1.44
GRID    4050            520.25  29.41    9.99
GRID    4051            520.25  29.19   18.58
GRID    4052            520.25  27.48   30.29
GRID    4053            520.25  26.04   33.54
GRID    4054            520.25  19.39   38.70
GRID    4055            520.25  12.98   40.16
GRID    4056            520.25  0.0     40.79
$
$ --- ENGINE MOUNT GRID POINT FOR MASS AND LOAD APPLICATION
$:GRID--ID------CP------X1------X2 -----X3------CD------PS------SEID--
GRID     4058            530.    24.      0.              0
$
GRID    4061            545.    0.      -23.067
GRID    4062            545.    13.026  -22.954
GRID    4063            545.    25.976  -21.785
GRID    4064            545.    31.764  -15.947
GRID    4065            545.    32.738  -7.22
GRID    4066            545.    34.909  1.44
GRID    4067            545.    34.909  9.969
GRID    4068            545.    34.909  17.783
GRID    4069            545.    31.736  27.883
GRID    4070            545.    28.665  36.062
GRID    4071            545.    21.777  41.31
GRID    4072            545.    13.222  43.246
GRID    4073            545.    0.      43.85
```

GRID	4074	545.	0.	-17.067
GRID	4075	545.	12.695	-16.425
GRID	4076	545.	22.213	-14.511
GRID	4077	545.	24.744	-11.401
GRID	4078	545.	26.248	-6.795
GRID	4079	545.	26.448	1.611
GRID	4080	545.	26.627	10.494
GRID	4081	545.	26.777	17.947
GRID	4082	545.	25.723	25.625
GRID	4083	545.	22.631	30.811
GRID	4084	545.	18.03	34.529
GRID	4085	545.	12.242	36.475
GRID	4086	545.	0.	36.65
$				
GRID	4091	581.	0.	-20.924
GRID	4092	581.	12.349	-20.818
GRID	4093	581.	24.655	-19.911
GRID	4094	581.	31.183	-15.271
GRID	4095	581.	32.49	-6.953
GRID	4096	581.	34.909	1.44
GRID	4097	581.	34.909	9.935
GRID	4098	581.	34.909	16.578
GRID	4099	581.	31.817	26.781
GRID	4100	581.	28.698	34.539
GRID	4101	581.	21.55	38.741
GRID	4102	581.	13.222	40.005
GRID	4103	581.	0.	40.403
GRID	4104	581.	0.	-14.924
GRID	4105	581.	12.213	-14.818
GRID	4106	581.	20.79	-13.511
GRID	4107	581.	23.537	-10.741
GRID	4108	581.	24.655	-6.663
GRID	4109	581.	24.655	1.44
GRID	4110	581.	24.655	9.935
GRID	4111	581.	24.655	16.578
GRID	4112	581.	24.655	21.93
GRID	4113	581.	22.089	29.345
GRID	4114	581.	18.267	32.536
GRID	4115	581.	12.655	33.93
GRID	4116	581.	0.	33.93
$				
GRID	4121	615.	0.	-17.374
GRID	4122	615.	11.76	-17.306
GRID	4123	615.	23.5	-16.672
GRID	4124	615.	30.226	-13.464
GRID	4125	615.	31.952	-6.015
GRID	4126	615.	34.909	1.44
GRID	4127	615.	34.909	9.903
GRID	4128	615.	34.909	15.44
GRID	4129	615.	31.513	24.804
GRID	4130	615.	27.962	31.457
GRID	4131	615.	20.901	34.202
GRID	4132	615.	13.222	34.928
GRID	4133	615.	0.	35.164

```
GRID    4134            615.    0.      -11.374
GRID    4135            615.    11.651  -11.306
GRID    4136            615.    20.633  -10.594
GRID    4137            615.    22.73   -8.738
GRID    4138            615.    23.5    -6.051
GRID    4139            615.    23.5    1.44
GRID    4140            615.    23.5    9.409
GRID    4141            615.    23.5    15.44
GRID    4142            615.    22.955  22.133
GRID    4143            615.    20.946  25.96
GRID    4144            615.    17.682  28.844
GRID    4145            615.    11.5    30.559
GRID    4146            615.    0.      30.559
$
GRID    4151            648.5   0.      -12.081
GRID    4152            648.5   11.698  -11.831
GRID    4153            648.5   23.4    -11.601
GRID    4154            648.5   29.436   -9.654
GRID    4155            648.5   31.188   -3.536
GRID    4156            648.5   31.463   2.94
GRID    4157            648.5   31.506   9.422
GRID    4158            648.5   31.383  15.903
GRID    4159            648.5   30.44   22.296
GRID    4160            648.5   26.082  26.724
GRID    4161            648.5   19.695  27.764
GRID    4162            648.5   13.223  28.136
GRID    4163            648.5   0.      28.227
$
GRID    4164            648.5   0.      -8.028
GRID    4165            648.5   11.65   -7.962
GRID    4166            648.5   23.23   -7.666
GRID    4167            648.5   26.71   -6.414
GRID    4168            648.5   27.14   -4.421
GRID    4169            648.5   27.14    2.898
GRID    4170            648.5   27.14    9.397
GRID    4171            648.5   27.14   15.955
GRID    4172            648.5   26.72   21.06
GRID    4173            648.5   24.25   23.19
GRID    4174            648.5   19.70   23.76
GRID    4175            648.5   13.22   24.14
GRID    4176            648.5   0.      24.23
$
$:CONROD-EID----G1------G2------MID-----A-------J-------C-------NSM-----
$:CROD--EID-----PID-----G1------G2------TMAX----
$
$ --- BHD 495.5 ROD ABOVE ENGINE ACCESSORY DRIVE
CROD    4114    4114    4018    4017
$
$ --- AFT FUSELAGE LONGERONS
$
$ ---   LOWER
$
CROD    4501    1       4003    4033
CROD    4502    1       4033    4063
```

```
CROD    4503    1       4063    4093
CROD    4504    1       4093    4123
CROD    4505    1       4123    4153
$
$ ---   UPPER
$
CROD    4511    1       4010    4040
CROD    4512    1       4040    4070
CROD    4513    1       4070    4100
CROD    4514    1       4100    4130
CROD    4515    1       4130    4160
CROD    4521    1       4012    4042
$
$ ---  WING LUG STIFFENERS
$ ---   LOWER
$
CROD    4531    1       4006    4036
CROD    4532    1       4036    4066
CROD    4533    1       4066    4096
CROD    4534    1       4096    4126
$
$ ---   UPPER
$
CROD    4541    1       4008    4038
CROD    4542    1       4038    4068
CROD    4543    1       4068    4098
CROD    4544    1       4098    4128
$
$ --- CBARS BELOW CONNECT FWD ENGINE MOUNT GRID 4058 TO THE FUSELAGE STRUCTURE
$ ---  NON-DESIGNED WITH PIN ENDS AT THE FRAME CONNECTION GRIDS
$
$:CBAR--EID-----PID-----GA------GB------X1,GO---X2------X3-------------
CBAR    4655    4655    4036    4058    0.      1.      0.              +CB4655
+CB4655 456
CBAR    4656    4655    4038    4058    0.      1.      0.              +CB4656
+CB4656 456
CBAR    4657    4655    4066    4058    0.      1.      0.              +CB4657
+CB4657 456
CBAR    4658    4655    4068    4058    0.      1.      0.              +CB4658
+CB4658 456
$:+CBAR-PA------PB------W1A-----W2A-----W3A-----W1B-----W2B-----W3B-----
$
$:CQUAD4-EID----PID-----G1------G2------G3------G4------THETA---ZOFFS---
$
CQUAD4  4001    1003    4031    4001    4002    4032    1
CQUAD4  4002    1003    4032    4002    4003    4033    1
CQUAD4  4003    1       4033    4003    4004    4034    1
CQUAD4  4004    1       4034    4004    4005    4035    1
CQUAD4  4005    1       4035    4005    4006    4036    1
CQUAD4  4006    1       4036    4006    4007    4037    1
CQUAD4  4007    1       4037    4007    4008    4038    1
CQUAD4  4008    1       4038    4008    4009    4039    1
CQUAD4  4009    1       4039    4009    4010    4040    1
CQUAD4  4010    1       4040    4010    4011    4041    1
```

```
CQUAD4  4011    1003    4041    4011    4012    4042    1
CQUAD4  4012    1003    4042    4012    4013    4043    1
$
CQUAD4  4021    1003    4061    4031    4032    4062    1
CQUAD4  4022    1003    4062    4032    4033    4063    1
CQUAD4  4023    1       4063    4033    4034    4064    1
CQUAD4  4024    1       4064    4034    4035    4065    1
CQUAD4  4025    1       4065    4035    4036    4066    1
CQUAD4  4026    1       4066    4036    4037    4067    1
CQUAD4  4027    1       4067    4037    4038    4068    1
CQUAD4  4028    1       4068    4038    4039    4069    1
CQUAD4  4029    1       4069    4039    4040    4070    1
CQUAD4  4030    1       4070    4040    4041    4071    1
CQUAD4  4031    1003    4071    4041    4042    4072    1
CQUAD4  4032    1003    4072    4042    4043    4073    1
$
CQUAD4  4041    1003    4091    4061    4062    4092    1
CQUAD4  4042    1003    4092    4062    4063    4093    1
CQUAD4  4043    1       4093    4063    4064    4094    1
CQUAD4  4044    1       4094    4064    4065    4095    1
CQUAD4  4045    1       4095    4065    4066    4096    1
CQUAD4  4046    1       4096    4066    4067    4097    1
CQUAD4  4047    1       4097    4067    4068    4098    1
CQUAD4  4048    1       4098    4068    4069    4099    1
CQUAD4  4049    1       4099    4069    4070    4100    1
CQUAD4  4050    1       4100    4070    4071    4101    1
CQUAD4  4051    1003    4101    4071    4072    4102    1
CQUAD4  4052    1003    4102    4072    4073    4103    1
$
CQUAD4  4061    1003    4121    4091    4092    4122    1
CQUAD4  4062    1003    4122    4092    4093    4123    1
CQUAD4  4063    1       4123    4093    4094    4124    1
CQUAD4  4064    1       4124    4094    4095    4125    1
CQUAD4  4065    1       4125    4095    4096    4126    1
CQUAD4  4066    1       4126    4096    4097    4127    1
CQUAD4  4067    1       4127    4097    4098    4128    1
CQUAD4  4068    1       4128    4098    4099    4129    1
CQUAD4  4069    1       4129    4099    4100    4130    1
CQUAD4  4070    1       4130    4100    4101    4131    1
CQUAD4  4071    1003    4131    4101    4102    4132    1
CQUAD4  4072    1003    4132    4102    4103    4133    1
$
CQUAD4  4081    1003    4151    4121    4122    4152    1
CQUAD4  4082    1003    4152    4122    4123    4153    1
CQUAD4  4083    1       4153    4123    4124    4154    1
CQUAD4  4084    1       4154    4124    4125    4155    1
CQUAD4  4085    1       4155    4125    4126    4156    1
CQUAD4  4086    1       4156    4126    4127    4157    1
CQUAD4  4087    1       4157    4127    4128    4158    1
CQUAD4  4088    1       4158    4128    4129    4159    1
CQUAD4  4089    1       4159    4129    4130    4160    1
CQUAD4  4090    1       4160    4130    4131    4161    1
CQUAD4  4091    1003    4161    4131    4132    4162    1
CQUAD4  4092    1003    4162    4132    4133    4163    1
```

```
$
$ --- BHD 495.5
$
CQUAD4  4101    1003    4001    4002    4015    4014    2
CQUAD4  4102    1003    4002    4003    4016    4015    2
CQUAD4  4103    1003    4003    4004    4005    4016    2
CQUAD4  4104    1003    4015    4016    4019    4018    2
CQUAD4  4105    1003    4005    4020    4019    4016    2
CQUAD4  4106    1003    4006    4021    4020    4005    2
CQUAD4  4107    1003    4007    4022    4021    4006    2
CQUAD4  4108    1003    4022    4007    4008    4023    2
CQUAD4  4109    1003    4023    4008    4009    4024    2
CQUAD4  4110    1003    4024    4009    4010    4025    2
CQUAD4  4111    1003    4010    4011    4026    4025    2
CQUAD4  4112    1003    4011    4012    4027    4026    2
CQUAD4  4113    1003    4028    4027    4012    4013    2
$
$ --- FRAME 520.25
$
CQUAD4  4121    1003    4031    4032    4045    4044    2
CQUAD4  4122    1003    4032    4033    4046    4045    2
CQUAD4  4123    1003    4034    4047    4046    4033    2
CQUAD4  4124    1003    4047    4034    4035    4048    2
CQUAD4  4125    1003    4048    4035    4036    4049    2
CQUAD4  4126    1003    4049    4036    4037    4050    2
CQUAD4  4127    1003    4050    4037    4038    4051    2
CQUAD4  4128    1003    4051    4038    4039    4052    2
CQUAD4  4129    1003    4052    4039    4040    4053    2
CQUAD4  4130    1003    4054    4053    4040    4041    2
CQUAD4  4131    1003    4055    4054    4041    4042    2
CQUAD4  4132    1003    4056    4055    4042    4043    2
$
$ --- BHD 545
$
CQUAD4  4141    1003    4061    4062    4075    4074    2
CQUAD4  4142    1003    4062    4063    4076    4075    2
CQUAD4  4143    1003    4063    4064    4077    4076    2
CQUAD4  4144    1003    4065    4078    4077    4064    2
CQUAD4  4145    1003    4066    4079    4078    4065    2
CQUAD4  4146    1003    4067    4080    4079    4066    2
CQUAD4  4147    1003    4068    4081    4080    4067    2
CQUAD4  4148    1003    4069    4082    4081    4068    2
CQUAD4  4149    1003    4070    4083    4082    4069    2
CQUAD4  4150    1003    4070    4071    4084    4083    2
CQUAD4  4151    1003    4071    4072    4085    4084    2
CQUAD4  4152    1003    4086    4085    4072    4073    2
$
$ --- BHD 581
$
CQUAD4  4161    1003    4091    4092    4105    4104    2
CQUAD4  4162    1003    4092    4093    4106    4105    2
CQUAD4  4163    1003    4093    4094    4107    4106    2
CQUAD4  4164    1003    4095    4108    4107    4094    2
CQUAD4  4165    1003    4108    4095    4096    4109    2
```

```
CQUAD4  4166    1003    4109    4096    4097    4110    2
CQUAD4  4167    1003    4110    4097    4098    4111    2
CQUAD4  4168    1003    4111    4098    4099    4112    2
CQUAD4  4169    1003    4112    4099    4100    4113    2
CQUAD4  4170    1003    4113    4100    4101    4114    2
CQUAD4  4171    1003    4115    4114    4101    4102    2
CQUAD4  4172    1003    4116    4115    4102    4103    2
$
$ --- BHD 615
$
CQUAD4  4181    1003    4121    4122    4135    4134    2
CQUAD4  4182    1003    4122    4123    4136    4135    2
CQUAD4  4183    1003    4123    4124    4137    4136    2
CQUAD4  4184    1003    4125    4138    4137    4124    2
CQUAD4  4185    1003    4126    4139    4138    4125    2
CQUAD4  4186    1003    4127    4140    4139    4126    2
CQUAD4  4187    1003    4128    4141    4140    4127    2
CQUAD4  4188    1003    4129    4142    4141    4128    2
CQUAD4  4189    1003    4130    4143    4142    4129    2
CQUAD4  4190    1003    4130    4131    4144    4143    2
CQUAD4  4191    1003    4131    4132    4145    4144    2
CQUAD4  4192    1003    4146    4145    4132    4133    2
$
$ --- BHD 645.5
$
CQUAD4  4201    1003    4151    4152    4165    4164    2
CQUAD4  4202    1003    4152    4153    4166    4165    2
CQUAD4  4203    1003    4153    4154    4167    4166    2
CQUAD4  4204    1003    4155    4168    4167    4154    2
CQUAD4  4205    1003    4156    4169    4168    4155    2
CQUAD4  4206    1003    4157    4170    4169    4156    2
CQUAD4  4207    1003    4158    4171    4170    4157    2
CQUAD4  4208    1003    4159    4172    4171    4158    2
CQUAD4  4209    1003    4172    4159    4160    4173    2
CQUAD4  4210    1003    4160    4161    4174    4173    2
CQUAD4  4211    1003    4175    4174    4161    4162    2
CQUAD4  4212    1003    4176    4175    4162    4163    2
$
$:CONM2-EID-----G-------CID-----M-------X1------X2------X3------   ------
$
CONM2   41651   4165            .1969
CONM2   41051   4105            .2073
CONM2   40581   4058            .1477
$
CONM2   40141   4014            .1222
CONM2   40151   4015            .1222
CONM2   40181   4018            .1222
$
CONM2   40441   4044            .2591
CONM2   40451   4045            .2591
$
CONM2   40051   4005            .0764
CONM2   40061   4006            .0764
$
```

```
CONM2   40351   4035            .2267
CONM2   40361   4036            .2267
$
CONM2   40582   4058            2.7021
CONM2   41391   4139            .035
$
CONM2   41091   4109            .1049
CONM2   41101   4110            .1049
$
CONM2   41392   4139            .169
CONM2   41401   4140            .169
$
CONM2   41691   4169            .094
CONM2   41701   4170            .094
CONM2   41711   4171            .094
$
$:SPC1--SID-----C-------G1------G2------G3------G4------G5------G6------
$
SPC1    10         3    4017
$
SPC1    10      246     4001    4014    4017    4028    4013
SPC1    10      246     4031    4044    4056    4043
SPC1    10      246     4061    4074    4086    4073
SPC1    10      246     4091    4104    4116    4103
SPC1    10      246     4121    4134    4146    4133
SPC1    10      246     4151    4164    4176    4163
$
SPC1    10        1     4014    4015    4016    4017    4018    4019
SPC1    10        1     4020    4021    4022    4023    4024    4025
SPC1    10        1     4026    4027    4028
SPC1    10        1     4044    4045    4046    4047    4048    4049
SPC1    10        1     4050    4051    4052    4053    4054    4055
SPC1    10        1     4056
SPC1    10        1     4074    4075    4076    4077    4078    4079
SPC1    10        1     4080    4081    4082    4083    4084    4085
SPC1    10        1     4086
SPC1    10        1     4104    4105    4106    4107    4108    4109
SPC1    10        1     4110    4111    4112    4113    4114    4115
SPC1    10        1     4116
SPC1    10        1     4134    4135    4136    4137    4138    4139
SPC1    10        1     4140    4141    4142    4143    4144    4145
SPC1    10        1     4146
SPC1    10        1     4164    4165    4166    4167    4168    4169
SPC1    10        1     4170    4171    4172    4173    4174    4175
SPC1    10        1     4176
$
$ - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
$
$ --- MAIN LANDING GEAR / VERTICAL FIN    POD SECTION
$
$:MAT1--MID-----E-------G-------NU------RHO-----A-------TREF----GE------
$MAT1    2024    1.03E7          0.3     2.59-4
$
$:PBAR--PID-----MID-----A-------I1------I2------J-------NSM------------
```

```
$ ---  PBAR BELOW IS FOR NONDESIGNED VERTICAL TAIL SPARS
$PBAR     5411    2023   13.5     100.      600.   30.
$
$
$:PSHELL-PID----MID1----T-------MID2----12I/T**3-MID3---TS/T----NSM-----
$PSHELL    1      2024    0.05
$PSHELL   50      2024    0.05
$
$
$ --- MPC BELOW CONNECT POD TO WING
$
$:MPC---SID-----G0------C0------A0------G-------C-------A-------        CONTINUE
MPC      55      1029    1      -1.     5001    1       1.
MPC      55      1029    2      -1.     5001    2       1.
MPC      55      1029    3      -1.     5001    3       1.
$
MPC      55      1049    1      -1.     5008    1       1.
MPC      55      1049    2      -1.     5008    2       1.
MPC      55      1049    3      -1.     5008    3       1.
$
MPC      55      1069    1      -1.     5007    1       1.
MPC      55      1069    2      -1.     5007    2       1.
MPC      55      1069    3      -1.     5007    3       1.
$
$
MPC      55      1031    1      -1.     5021    1       1.
MPC      55      1031    2      -1.     5021    2       1.
MPC      55      1031    3      -1.     5021    3       1.
$
MPC      55      1051    1      -1.     5034    1       1.
MPC      55      1051    2      -1.     5034    2       1.
MPC      55      1051    3      -1.     5034    3       1.
$
MPC      55      1071    1      -1.     5027    1       1.
MPC      55      1071    2      -1.     5027    2       1.
MPC      55      1071    3      -1.     5027    3       1.
$
$
MPC      55      1032    1      -1.     5032    1       1.
MPC      55      1032    2      -1.     5032    2       1.
MPC      55      1032    3      -1.     5032    3       1.
$
MPC      55      1052    1      -1.     5035    1       1.
MPC      55      1052    2      -1.     5035    2       1.
MPC      55      1052    3      -1.     5035    3       1.
$
MPC      55      1072    1      -1.     5028    1       1.
MPC      55      1072    2      -1.     5028    2       1.
MPC      55      1072    3      -1.     5028    3       1.
$
$
MPC      55      1033    1      -1.     5041    1       1.
MPC      55      1033    2      -1.     5041    2       1.
MPC      55      1033    3      -1.     5041    3       1.
```

```
$
MPC     55      1053    1       -1.     5054    1       1.
MPC     55      1053    2       -1.     5054    2       1.
MPC     55      1053    3       -1.     5054    3       1.
$
MPC     55      1073    1       -1.     5047    1       1.
MPC     55      1073    2       -1.     5047    2       1.
MPC     55      1073    3       -1.     5047    3       1.
$
$
MPC     55      1034    1       -1.     5052    1       1.
MPC     55      1034    2       -1.     5052    2       1.
MPC     55      1034    3       -1.     5052    3       1.
$
MPC     55      1054    1       -1.     5055    1       1.
MPC     55      1054    2       -1.     5055    2       1.
MPC     55      1054    3       -1.     5055    3       1.
$
MPC     55      1074    1       -1.     5048    1       1.
MPC     55      1074    2       -1.     5048    2       1.
MPC     55      1074    3       -1.     5048    3       1.
$
$
MPC     55      1075    1       -1.     5067    1       1.
MPC     55      1075    2       -1.     5067    2       1.
MPC     55      1075    3       -1.     5067    3       1.
$
MPC     55      1076    1       -1.     5068    1       1.
MPC     55      1076    2       -1.     5068    2       1.
MPC     55      1076    3       -1.     5068    3       1.
$
$
$:GRID---ID-----CP------X1------X2 -----X3------CD------PS------SEID----
GRID    5001            545.    59.     4.23
GRID    5002            545.    60.578  -2.167
GRID    5003            545.    64.535  -5.689
GRID    5004            545.    69.999  -6.317
GRID    5005            545.    75.41   -5.672
GRID    5006            545.    79.364  -2.188
GRID    5007            545.    81.     2.336
GRID    5008            545.    70.     3.276
GRID    5009            545.    69.971  -2.178
$
GRID    5021            581.    59.     4.834
GRID    5022            581.    59.271  -3.893
GRID    5023            581.    61.795  -12.09
GRID    5024            581.    69.998  -14.332
GRID    5025            581.    77.691  -12.534
GRID    5026            581.    80.588  -5.241
GRID    5027            581.    81.     2.801
GRID    5028            581.    81.     10.607
GRID    5029            581.    76.331  15.532
GRID    5030            581.    70.238  16.877
GRID    5031            581.    64.982  16.222
```

```
GRID    5032            581.    59.     13.24
GRID    5033            581.    69.929  -4.567
GRID    5034            581.    70.     3.813
GRID    5035            581.    70.     11.925
$
GRID    5041            615.    59.     5.71
GRID    5042            615.    59.519  -4.306
GRID    5043            615.    61.318  -14.108
GRID    5044            615.    69.999  -17.902
GRID    5045            615.    78.305  -14.687
GRID    5046            615.    80.381  -5.682
GRID    5047            615.    81.     3.635
GRID    5048            615.    81.     9.054
GRID    5049            615.    77.445  16.495
GRID    5050            615.    69.999  19.187
GRID    5051            615.    63.429  17.219
GRID    5052            615.    59.     11.406
GRID    5053            615.    69.95   -4.994
GRID    5054            615.    70.     4.673
GRID    5055            615.    70.     10.23
$
GRID    5061            633.    58.999  6.066
GRID    5062            633.    59.423  -4.249
GRID    5063            633.    61.22   -14.356
GRID    5064            633.    70.001  -18.474
GRID    5065            633.    78.433  -14.932
GRID    5066            633.    80.477  -5.59
GRID    5067            633.    81.     4.045
GRID    5068            633.    81.     7.813
GRID    5069            633.    78.003  16.218
GRID    5070            633.    69.998  19.512
GRID    5071            633.    62.735  17.045
GRID    5072            633.    59.436  10.067
GRID    5073            633.    69.95   -4.919
GRID    5074            633.    69.999  5.055
GRID    5075            633.    70.101  8.953
$
GRID    5081            655.    59.082  6.122
GRID    5082            655.    59.246  -4.165
GRID    5083            655.    61.046  -14.227
GRID    5084            655.    69.999  -17.977
GRID    5085            655.    78.942  -14.246
GRID    5086            655.    80.749  -4.206
GRID    5087            655.    80.915  6.06
GRID    5088            655.    78.643  15.558
GRID    5089            655.    69.999  19.523
GRID    5090            655.    61.376  15.591
GRID    5091            655.    69.998  -4.185
GRID    5092            655.    69.998  6.091
$
GRID    5101            680.    59.084  6.468
GRID    5102            680.    59.308  -3.249
GRID    5103            680.    61.328  -12.665
GRID    5104            680.    70.     -15.912
```

```
GRID    5105            680.    78.67   -12.665
GRID    5106            680.    80.69   -3.249
GRID    5107            680.    80.914  6.468
GRID    5108            680.    78.522  15.732
GRID    5109            680.    70.     19.522
GRID    5110            680.    61.476  15.732
GRID    5111            680.    69.999  -3.249
GRID    5112            680.    69.999  6.468
$
GRID    5121            695.    59.347  7.258
GRID    5122            695.    59.479  -2.018
GRID    5123            695.    61.643  -10.948
GRID    5124            695.    69.999  -13.918
GRID    5125            695.    78.355  -10.948
GRID    5126            695.    80.519  -2.011
GRID    5127            695.    80.651  7.257
GRID    5128            695.    78.251  16.07
$
$:GRID---ID-----CP------X1------X2 -----X3------CD------PS------SEID----
GRID    5129            695.    69.999  19.523          0
GRID    5130            695.    61.746  16.07
GRID    5131            695.    69.999  -2.015          0
GRID    5132            695.    69.999  7.257
GRID    5133            770.    47.96   101.78          0
$
GRID    5141            735.    60.8    10.494
GRID    5142            735.    60.921  3.28
GRID    5143            735.    63.453  -3.391
GRID    5144            735.    69.999  -5.745
GRID    5145            735.    76.526  -3.364
GRID    5146            735.    79.039  3.308
GRID    5147            735.    79.155  10.502
GRID    5148            735.    76.55   17.148
$
$:GRID--ID------CP------X1------X2 -----X3------CD------PS------SEID----
GRID    5149            735.    69.958  19.523          0
GRID    5150            735.    63.402  17.144
GRID    5151            735.    69.98   3.294           0
GRID    5152            735.    69.977  10.498
GRID    5153            782.6   47.96   101.78          0
$
GRID    5161            751.    62.103  12.231
GRID    5162            751.    62.035  6.206
GRID    5163            751.    64.452  0.782
GRID    5164            751.    69.999  -1.255
GRID    5165            751.    75.548  0.785
GRID    5166            751.    77.963  6.205
GRID    5167            751.    77.895  12.231
GRID    5168            751.    75.608  17.75
GRID    5169            751.    69.999  19.523
GRID    5170            751.    64.388  17.748
GRID    5171            751.    69.999  6.205
GRID    5172            751.    69.999  12.231
$
```

```
$:CONROD EID----G1------G2------MID-----A-------J-------C-------NSM-----
$
$ --- THIS UNDESIGNED ROD CONNECTS THE POD LATERALLY TO THE AFT MOST FUSL FRAME
$ ---                                  STA 655  BL 31.2     STA 648.5  BL 59
$ ---      MATL = 409 FOR COMPOSITE RODS
$
CONROD   5400    5081    4158    409     .12
$
$:CROD--EID-----PID-----G1------G2------TMAX----
$
$CROD    5401     1      5129    5133    $
$CROD    5402     1      5149    5153    $ --- SEE BELOW FOR REPLACEMENTS
$CROD    5403     1      5133    5153    $
CROD    5404     1      5149    5133
$
$:CBAR--EID-----PID-----GA------GB------X1,G0---X2------X3-------------
$ --- CBARS BELOW CRUDELY MODEL VERTICAL - H-PATTERN  ( OVERLAPS ON BHDS )
$ ---   FIRST AND LAST SPARS ONLY - SAME FOUR NODES AS PREVIOUS ROD VERSION
$
CBAR    5411    5411    5131    5129    0.      1.      0.
CBAR    5412    5411    5129    5133    0.      1.      0.
CBAR    5415    5411    5129    5149    0.      1.      0.
CBAR    5416    5411    5133    5153    0.      1.      0.
CBAR    5421    5411    5151    5149    0.      1.      0.
CBAR    5422    5411    5149    5153    0.      1.      0.
$
$:CROD--EID-----PID-----G1------G2------TMAX----
$
$ --- TOP STIFFENER
CROD     5502   1       5035    5050
CROD     5503   1       5050    5070
CROD     5504   1       5070    5089
CROD     5505   1       5089    5109
CROD     5506   1       5109    5129
CROD     5507   1       5129    5149
CROD     5508   1       5149    5169
$
$ --- BOT STIFFENER
CROD     5511   1       5009    5024
CROD     5512   1       5024    5044
CROD     5513   1       5044    5064
CROD     5514   1       5064    5084
CROD     5515   1       5084    5104
CROD     5516   1       5104    5124
CROD     5517   1       5124    5144
CROD     5518   1       5144    5164
$
$ --- INBD STIFFENER
CROD     5522   1       5021    5041
CROD     5523   1       5041    5061
CROD     5524   1       5061    5081
CROD     5525   1       5081    5101
CROD     5526   1       5101    5121
CROD     5527   1       5121    5141
```

```
CROD     5528    1       5141    5161
$
$ --- OUTBD STIFFENER
CROD     5532    1       5027    5047
CROD     5533    1       5047    5067
CROD     5534    1       5067    5087
CROD     5535    1       5087    5107
CROD     5536    1       5107    5127
CROD     5537    1       5127    5147
CROD     5538    1       5147    5167
$
$:CQUAD4 EID----PID-----G1------G2------G3------G4------THETA---ZOFFS---
$
CQUAD4  5001    1       5001    5002    5022    5021    1
CQUAD4  5002    1       5002    5003    5023    5022    1
CQUAD4  5003    1003    5003    5004    5024    5023    1
CQUAD4  5004    1003    5005    5004    5024    5025    1
CQUAD4  5005    1       5006    5005    5025    5026    1
CQUAD4  5006    1       5007    5006    5026    5027    1
$
CQUAD4  5021    1       5021    5022    5042    5041    1
CQUAD4  5022    1       5022    5023    5043    5042    1
CQUAD4  5023    1003    5023    5024    5044    5043    1
CQUAD4  5024    1003    5025    5024    5044    5045    1
CQUAD4  5025    1       5026    5025    5045    5046    1
CQUAD4  5026    1       5027    5026    5046    5047    1
CQUAD4  5027    1       5029    5028    5048    5049    1
CQUAD4  5028    1003    5030    5029    5049    5050    1
CQUAD4  5029    1003    5030    5031    5051    5050    1
CQUAD4  5030    1       5031    5032    5052    5051    1
$
CQUAD4  5041    1       5041    5042    5062    5061    1
CQUAD4  5042    1       5042    5043    5063    5062    1
CQUAD4  5043    1003    5043    5044    5064    5063    1
CQUAD4  5044    1003    5045    5044    5064    5065    1
CQUAD4  5045    1       5046    5045    5065    5066    1
CQUAD4  5046    1       5047    5046    5066    5067    1
CQUAD4  5047    1       5049    5048    5068    5069    1
CQUAD4  5048    1003    5050    5049    5069    5070    1
CQUAD4  5049    1003    5050    5051    5071    5070    1
CQUAD4  5050    1       5051    5052    5072    5071    1
$
CQUAD4  5061    1       5061    5062    5082    5081    1
CQUAD4  5062    1       5062    5063    5083    5082    1
CQUAD4  5063    1003    5063    5064    5084    5083    1
CQUAD4  5064    1003    5065    5064    5084    5085    1
CQUAD4  5065    1       5066    5065    5085    5086    1
CQUAD4  5066    1       5067    5066    5086    5087    1
CQUAD4  5067    1       5069    5068    5087    5088    1
CQUAD4  5068    1003    5070    5069    5088    5089    1
CQUAD4  5069    1003    5070    5071    5090    5089    1
CQUAD4  5070    1       5071    5072    5081    5090    1
$
CQUAD4  5081    1       5081    5082    5102    5101    1
```

```
CQUAD4  5082    1       5082    5083    5103    5102    1
CQUAD4  5083    1003    5083    5084    5104    5103    1
CQUAD4  5084    1003    5085    5084    5104    5105    1
CQUAD4  5085    1       5086    5085    5105    5106    1
CQUAD4  5086    1       5087    5086    5106    5107    1
CQUAD4  5087    1       5088    5087    5107    5108    1
CQUAD4  5088    1003    5089    5088    5108    5109    1
CQUAD4  5089    1003    5089    5090    5110    5109    1
CQUAD4  5090    1       5090    5081    5101    5110    1
$
CQUAD4  5101    1       5101    5102    5122    5121    1
CQUAD4  5102    1       5102    5103    5123    5122    1
CQUAD4  5103    1003    5103    5104    5124    5123    1
CQUAD4  5104    1003    5105    5104    5124    5125    1
CQUAD4  5105    1       5106    5105    5125    5126    1
CQUAD4  5106    1       5107    5106    5126    5127    1
CQUAD4  5107    1       5108    5107    5127    5128    1
CQUAD4  5108    1003    5109    5108    5128    5129    1
CQUAD4  5109    1003    5109    5110    5130    5129    1
CQUAD4  5110    1       5110    5101    5121    5130    1
$
CQUAD4  5121    1       5121    5122    5142    5141    1
CQUAD4  5122    1       5122    5123    5143    5142    1
CQUAD4  5123    1003    5123    5124    5144    5143    1
CQUAD4  5124    1003    5125    5124    5144    5145    1
CQUAD4  5125    1       5126    5125    5145    5146    1
CQUAD4  5126    1       5127    5126    5146    5147    1
CQUAD4  5127    1       5128    5127    5147    5148    1
CQUAD4  5128    1003    5129    5128    5148    5149    1
CQUAD4  5129    1003    5129    5130    5150    5149    1
CQUAD4  5130    1       5130    5121    5141    5150    1
$
CQUAD4  5141    1       5141    5142    5162    5161    1
CQUAD4  5142    1       5142    5143    5163    5162    1
CQUAD4  5143    1003    5143    5144    5164    5163    1
CQUAD4  5144    1003    5145    5144    5164    5165    1
CQUAD4  5145    1       5146    5145    5165    5166    1
CQUAD4  5146    1       5147    5146    5166    5167    1
CQUAD4  5147    1       5148    5147    5167    5168    1
CQUAD4  5148    1003    5149    5148    5168    5169    1
CQUAD4  5149    1003    5149    5150    5170    5169    1
CQUAD4  5150    1       5150    5141    5161    5170    1
$
$ --- BHD 545
$
CQUAD4  5201    1003    5008    5001    5002    5009    2
CQUAD4  5206    1003    5008    5007    5006    5009    2
$
$ --- BHD 581
$
CQUAD4  5221    1003    5034    5021    5022    5033    2
CQUAD4  5222    1003    5033    5022    5023    5024    2
CQUAD4  5223    1003    5033    5026    5025    5024    2
CQUAD4  5224    1003    5027    5034    5033    5026    2
```

```
$
$ --- BHD 615
$
CQUAD4  5241    1003    5054    5041    5042    5053    2
CQUAD4  5242    1003    5053    5042    5043    5044    2
CQUAD4  5243    1003    5053    5046    5045    5044    2
CQUAD4  5244    1003    5047    5054    5053    5046    2
CQUAD4  5245    1003    5050    5049    5048    5055    2
CQUAD4  5246    1003    5050    5051    5052    5055    2
$
$ --- BHD 633
$
CQUAD4  5261    1003    5074    5061    5062    5073    2
CQUAD4  5262    1003    5064    5063    5062    5073    2
CQUAD4  5263    1003    5073    5066    5065    5064    2
CQUAD4  5264    1003    5067    5074    5073    5066    2
CQUAD4  5265    1003    5070    5069    5068    5075    2
CQUAD4  5266    1003    5070    5071    5072    5075    2
$
$ --- BHD 655
$
CQUAD4  5281    1003    5092    5081    5082    5091    2
CQUAD4  5282    1003    5084    5083    5082    5091    2
CQUAD4  5283    1003    5091    5086    5085    5084    2
CQUAD4  5284    1003    5087    5092    5091    5086    2
CQUAD4  5285    1003    5089    5088    5087    5092    2
CQUAD4  5286    1003    5089    5090    5081    5092    2
$
$ --- BHD 680
$
CQUAD4  5301    1003    5112    5101    5102    5111    2
CQUAD4  5302    1003    5111    5102    5103    5104    2
CQUAD4  5303    1003    5111    5106    5105    5104    2
CQUAD4  5304    1003    5107    5112    5111    5106    2
CQUAD4  5305    1003    5109    5108    5107    5112    2
CQUAD4  5306    1003    5109    5110    5101    5112    2
$
$ --- BHD 695
$
CQUAD4  5321    1003    5132    5121    5122    5131    2
CQUAD4  5322    1003    5131    5122    5123    5124    2
CQUAD4  5323    1003    5131    5126    5125    5124    2
CQUAD4  5324    1003    5127    5132    5131    5126    2
CQUAD4  5325    1003    5129    5128    5127    5132    2
CQUAD4  5326    1003    5129    5130    5121    5132    2
$
$ --- BHD 735
$
CQUAD4  5341    1003    5152    5141    5142    5151    2
CQUAD4  5342    1003    5151    5142    5143    5144    2
CQUAD4  5343    1003    5151    5146    5145    5144    2
CQUAD4  5344    1003    5147    5152    5151    5146    2
CQUAD4  5345    1003    5149    5148    5147    5152    2
CQUAD4  5346    1003    5149    5150    5141    5152    2
```

```
$
$ --- BHD 751
$
CQUAD4  5361    1003    5172    5161    5162    5171    2
CQUAD4  5362    1003    5171    5162    5163    5164    2
CQUAD4  5363    1003    5171    5166    5165    5164    2
CQUAD4  5364    1003    5167    5172    5171    5166    2
CQUAD4  5365    1003    5169    5168    5167    5172    2
CQUAD4  5366    1003    5169    5170    5161    5172    2
$
$:CTRIA3-EID----PID-----G1------G2------G3------THETA---ZOFFS----------
$
CTRIA3  5202    1003    5009    5002    5003
CTRIA3  5203    1003    5009    5003    5004
CTRIA3  5204    1003    5009    5004    5005
CTRIA3  5205    1003    5009    5005    5006
$
CTRIA3  5225    1003    5035    5029    5028
CTRIA3  5226    1003    5035    5030    5029
CTRIA3  5227    1003    5035    5031    5030
CTRIA3  5228    1003    5035    5032    5031
$
$
$:CONM2-EID-----G-------CID-----M-------X1------X2------X3------  ------
$
CONM2   50531   5053            .7202
$
CONM2   50831   5083            .1136
CONM2   50841   5084            .1136
CONM2   50851   5085            .1136
$
CONM2   51031   5103            .2271
CONM2   51041   5104            .2271
CONM2   51051   5105            .2271
$
CONM2   51231   5123            .0568
CONM2   51241   5124            .0568
CONM2   51251   5125            .0568
$
CONM2   51291   5129            .1684
CONM2   51491   5149            .1684
CONM2   51331   5133            .0712
CONM2   51531   5153            .0725
$
CONM2   51221   5122            .1782
CONM2   51261   5126            .1782
CONM2   51311   5131            .1782
$
CONM2   51421   5142            .1069
CONM2   51461   5146            .1069
CONM2   51511   5151            .1069
$
CONM2   51711   5171            .0736
CONM2   51721   5172            .0736
```

```
$
$:SPC1--SID-----C-------G1------G2------G3------G4------G5------G6-----
$$$$SPC1     10        2       5133     5153 $ --- SEE BARS FOR VERTICAL
$$$$SPC1     10        1       5009     5131     5151 $ --- NOW HAVE F/A STIFFNESS
$
SPC1    10        1       5033     5053     5073     5074     5075
SPC1    10        1       5091     5092     5111     5112
SPC1    10        1       5132     5152
SPC1    10        1       5171     5172
$
$ - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
$
$ --- DESIGN CONSTRAINTS  - EXCEPT DCONFLT WHICH IS WITH FLUTTER
$
$DCONSTR MID     TYP      MID      TYP      MID      TYP
DCONSTR   49      STRAIN
DCONSTR   50      STRAIN
DCONSTR   120     STRAIN
DCONSTR   133     STRAIN
DCONSTR   150     VMISES
DCONSTR   409     VMISES
$
$DCONTHK-ETYPE--ELEM1---ELEM2---ELEM3---ELEM4---ELEM5---ELEM6---ELEM7---
DCONTHK   QDMEM1  1001     1121
$
DCONTHK   QDMEM1  1003     1131     1009     1069
DCONTHK   QDMEM1  1013     1093     1133
DCONTHK   QDMEM1  1204     1332     1210     1270
DCONTHK   QDMEM1  1214     1294     1334
DCONTHK   TRMEM   1087     1288     1109     1310
DCONTHK   QUAD4   1502     1532     1552
DCONTHK   QUAD4   1601     1607     1611     1624     1631     1635
DCONTHK   QUAD4   1641     1646     1651     1657     1664     1667
$
DCONTHK   QDMEM1  1075     1135
$
DCONTHK   QUAD4   2001     2102     2161     2004     2104     2164
DCONTHK   QUAD4   2010     2090     2171     2174
DCONTHK   QUAD4   2201     2221     2232     2261     2271
DCONTHK   QUAD4   2301     2311     2317
DCONTHK   ROD     2501     2511     2521     2531
$
DCONTHK   QUAD4   3001     3041     3101     3005     3045     3105
DCONTHK   QUAD4   3008     3053     3112
DCONTHK   QUAD4   3121     3141     3161     3191     3221     3251
DCONTHK   QUAD4   3271     3281     3304     3352
DCONTHK   QUAD4   3361     3381     3401
DCONTHK   ROD     3501     3506     3511     3516     3521     3526
DCONTHK   ROD     3551     3557     3561     3567
DCONTHK   QUAD4   3801     3831     3902     3981
$
$234567 2234567 323567 4234567 5234567 6234567 7234567 8234567 9234567 +CONTINUE
DCONTHK   QUAD4   4001     4041     4081     4004     4044     4084
DCONTHK   QUAD4   4010     4050     4090
```

```
DCONTHK   QUAD4   4101    4107    4113    4121    4141    4146    4152
DCONTHK   QUAD4   4161    4166    4172
DCONTHK   QUAD4   4181    4186    4192    4201
DCONTHK   ROD     4501    4505    4511    4515
DCONTHK   ROD     4531    4534    4541    4544
$
DCONTHK   QUAD4   5001    5061    5141    5063    5069
DCONTHK   QUAD4   5201    5241    5281    5341
DCONTHK   ROD     5502    5522
$
$ - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
$
$ --- BALANCE MASSES L/E SPAR
$CONM2--EID-----G-------CID-----M-------X1------X2------X3------
CONM2    91003   1003            .01
CONM2    91109   1109            .01
CONM2    91151   1151            .01
$
$ - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
$
$ --- DESELEMS FOR MASSES BALANCE AT LEADING EDGE SPAR AT ROOT MID AND TIP
$
$DESELM-DVID----EID-----ETYPE---VMIN----VMAX----VINIT---PLY-----LABEL
DESELM   91003   91003   CONM2                   1.              BAL1
DESELM   91109   91109   CONM2                   1.              BAL2
DESELM   91151   91151   CONM2                   1.              BAL3
$
$ --- DESELEM FOR INLET TO CENTER FUSELAGE TIE
DESELM   3299    3299    CQUAD4                  1.      1       INLETIE
$
$ --- DESELEM FOR ROD ABOVE ENGINE ACCESSORY CUTOUT BHD 495
DESELM   4114    4114    CROD                    1.              BH495RD
$
$ --- DESVARS WING
$
$DESVARS DVID---SHAPID--VMIN----VMAX----INIT----PLY-----PLYLIST-LABEL
$
$ ---     WING SKIN LABEL MNEMONICS:
$ ---                 1,2,3, OR 4 - PLY NUMBER
$ ---           NO TRAILING LETTER - CONSTANT SHAPE
$ ---                            S -  SPANWISE LINEAR SHAPE
$ ---                            C - CHORDWISE LINEAR SHAPE
$ ---                           SS -  SPANWISE QUADRATIC SHAPE
$ ---                           CC - CHORDWISE QUADRATIC SHAPE
$
$ --- DESVARS UPPER SKIN
$
DESVARS  101     100     -1000.  1000.   .016    1               LWRS1
DESVARS  102     100     -1000.  1000.   .009    2               LWRS2
DESVARS  103     100     -1000.  1000.   .009    3               LWRS3
DESVARS  104     100     -1000.  1000.   .015    4               LWRS4
$
DESVARS  111     110     -1000.  1000.   .034    1               LWRS1S
DESVARS  112     110     -1000.  1000.   .026    2               LWRS2S
```

```
DESVARS  113      110      -1000.   1000.     .026     3                    LWRS3S
DESVARS  114      110      -1000.   1000.     .03      4                    LWRS4S
$
DESVARS  115      120      -1000.   1000.     .0       1                    LWRS1C
DESVARS  116      120      -1000.   1000.     .0       2                    LWRS2C
DESVARS  117      120      -1000.   1000.     .0       3                    LWRS3C
DESVARS  118      120      -1000.   1000.     .0       4                    LWRS4C
$
$
DESVARS  121      130      -1000.   1000.    -.024     1                    LWRS1SS
DESVARS  122      130      -1000.   1000.    -.026     2                    LWRS2SS
DESVARS  123      130      -1000.   1000.    -.026     3                    LWRS3SS
DESVARS  124      130      -1000.   1000.    -.029     4                    LWRS4SS
$
DESVARS  125      140      -1000.   1000.     .005     1                    LWRS1CC
DESVARS  126      140      -1000.   1000.     .003     2                    LWRS2CC
DESVARS  127      140      -1000.   1000.     .003     3                    LWRS3CC
DESVARS  128      140      -1000.   1000.     .003     4                    LWRS4CC
$
$ --- DESVARS UPPER SKIN
$
DESVARS  201      200      -1000.   1000.     .029     1                    UPRS1
DESVARS  202      200      -1000.   1000.     .016     2                    UPRS2
DESVARS  203      200      -1000.   1000.     .009     3                    UPRS3
DESVARS  204      200      -1000.   1000.     .016     4                    UPRS4
$
DESVARS  211      210      -1000.   1000.     .046     1                    UPRS1S
DESVARS  212      210      -1000.   1000.     .029     2                    UPRS2S
DESVARS  213      210      -1000.   1000.     .025     3                    UPRS3S
DESVARS  214      210      -1000.   1000.     .035     4                    UPRS4S
$
DESVARS  215      220      -1000.   1000.    -.008     1                    UPRS1C
DESVARS  216      220      -1000.   1000.    -.005     2                    UPRS2C
DESVARS  217      220      -1000.   1000.    -.003     3                    UPRS3C
DESVARS  218      220      -1000.   1000.    -.002     4                    UPRS4C
$
$
DESVARS  221      230      -1000.   1000.    -.015     1                    UPRS1SS
DESVARS  222      230      -1000.   1000.    -.026     2                    UPRS2SS
DESVARS  223      230      -1000.   1000.    -.024     3                    UPRS3SS
DESVARS  224      230      -1000.   1000.    -.024     4                    UPRS4SS
$
DESVARS  225      240      -1000.   1000.    -.005     1                    UPRS1CC
DESVARS  226      240      -1000.   1000.     .002     2                    UPRS2CC
DESVARS  227      240      -1000.   1000.     .004     3                    UPRS3CC
DESVARS  228      240      -1000.   1000.     .0       4                    UPRS4CC
$
$ --- DESVARS RIBS
$
DESVARS  500      500      -1000.   1000.     .07      1                    RIB1-2
DESVARS  510      510      -1000.   1000.     .07      1                    RIB3-4
DESVARS  520      520      -1000.   1000.     .07      1                    RIB567
$
$ --- LABEL MNEMONICS
```

```
$ ---       C - CONSTANT SHAPE
$ ---       L -  LINEAR  SHAPE SPAN WISE
$
$ --- DESVARS SPARS
$
DESVARS  600     600     -1000.  1000.   .07     1               SPLE-C
DESVARS  610     610     -1000.  1000.   .07     1               SP12-C
DESVARS  630     630     -1000.  1000.   .07     1               SP3-C
DESVARS  640     640     -1000.  1000.   .07     1               SP4-C
DESVARS  650     650     -1000.  1000.   .064    1               SP5-C
DESVARS  660     660     -1000.  1000.   .064    1               SP6-C
$
$
DESVARS  601     601     -1000.  1000.   .00     1               SPLE-L
DESVARS  611     611     -1000.  1000.   .00     1               SP12-L
DESVARS  631     631     -1000.  1000.   .00     1               SP3-L
DESVARS  641     641     -1000.  1000.   .00     1               SP4-L
DESVARS  651     651     -1000.  1000.   .00     1               SP5-L
DESVARS  661     661     -1000.  1000.   .00     1               SP6-L
$
$
$ --- DESVARS LEADING EDGE
$
DESVARS  701     700     -1000.  1000.   .02     1               LE-C1
DESVARS  702     700     -1000.  1000.   .01     2               LE-C2
DESVARS  703     700     -1000.  1000.   .02     3               LE-C3
DESVARS  704     700     -1000.  1000.   .02     4               LE-C4
DESVARS  711     710     -1000.  1000.   .0      1               LE-L1
DESVARS  712     710     -1000.  1000.   .0      2               LE-L2
DESVARS  713     710     -1000.  1000.   .0      3               LE-L3
DESVARS  714     710     -1000.  1000.   .0      4               LE-L4
$
$ --- DESVARS AILERON
$
DESVARS  801     800     -1000.  1000.   .053    1               AIL-C1
DESVARS  802     800     -1000.  1000.   .02     2               AIL-C2
DESVARS  803     800     -1000.  1000.   .018    3               AIL-C3
DESVARS  804     800     -1000.  1000.   .02     4               AIL-C4
DESVARS  811     810     -1000.  1000.   .0      1               AIL-L1
DESVARS  812     810     -1000.  1000.   .0      2               AIL-L2
DESVARS  813     810     -1000.  1000.   .0      3               AIL-L3
DESVARS  814     810     -1000.  1000.   .0      4               AIL-L4
$
$ - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
$
$-------2-------3-------4-------5-------6-------7-------8-------9-------
$
$ ---   SHAPE FUNCTION DEFINITIONS FOR THE WING STRUCTURE
$
$ --- SHAPE LOWER SKIN FOR CONSTANT
SHAPE    100     CQDMEM1 1003    1.0     1005    1.0     1007    1.0     +S100A
+S100A   1009    1.0     1011    1.0     1013    1.0     1015    1.0     +S100B
+S100B   1023    1.0     1025    1.0     1027    1.0     1029    1.0     +S100C
+S100C   1031    1.0     1045    1.0     1047    1.0     1049    1.0     +S100D
```

```
+S100D   1051    1.0     1067    1.0     1069    1.0     1071    1.0     +S100E
+S100E   1073    1.0     1089    1.0     1091    1.0     1093    1.0     +S100F
+S100F   1111    1.0     1113    1.0     1131    1.0     1133    1.0
$
SHAPE    100     CTRMEM  1043    1.0     1065    1.0     1087    1.0     +S100G
+S100G   1109    1.0
$
$ --- SHAPE LOWER SKIN FOR LINEAR SPANWISE
SHAPE    110     CQDMEM1 1003     .93    1005     .93    1007     .93    +S110A
+S110A   1009     .93    1011     .93    1013     .93    1015     .93    +S110B
+S110B   1023     .80    1025     .80    1027     .80    1029     .80    +S110C
+S110C   1031     .80    1045     .73    1047     .73    1049     .73    +S110D
+S110D   1051     .73    1067     .64    1069     .64    1071     .64    +S110E
+S110E   1073     .64    1089     .49    1091     .49    1093     .49    +S110F
+S110F   1111     .30    1113     .30    1131     .09    1133     .09
$
SHAPE    110     CTRMEM  1043     .73    1065     .64    1087     .49    +S110G
+S110G   1109     .30
$
$ --- SHAPE LOWER SKIN FOR LINEAR CHORDWISE
SHAPE    120     CQDMEM1 1003     .91    1005     .76    1007     .62    +S120A
+S120A   1009     .45    1011     .26    1013     .09    1015     .09    +S120B
+S120B   1023     .96    1025     .84    1027     .68    1029     .49    +S120C
+S120C   1031     .26    1045     .84    1047     .68    1049     .49    +S120D
+S120D   1051     .26    1067     .80    1069     .56    1071     .28    +S120E
+S120E   1073     .074   1089     .69    1091     .36    1093     .10    +S120F
+S120F   1111     .52    1113     .15    1131     .77    1133     .28
$
SHAPE    120     CTRMEM  1043     .95    1065     .96    1087     .94    +S120G
+S120G   1109     .89
$
$ --- SHAPE LOWER SKIN FOR QUADRATIC SPANWISE
SHAPE    130     CQDMEM1 1003     .86    1005     .86    1007     .86    +S130A
+S130A   1009     .86    1011     .86    1013     .86    1015     .86    +S130B
+S130B   1023     .64    1025     .64    1027     .64    1029     .64    +S130C
+S130C   1031     .64    1045     .53    1047     .53    1049     .53    +S130D
+S130D   1051     .53    1067     .41    1069     .41    1071     .41    +S130E
+S130E   1073     .41    1089     .24    1091     .24    1093     .24    +S130F
+S130F   1111     .09    1113     .09    1131     .008   1133     .008
$
SHAPE    130     CTRMEM  1043     .53    1065     .41    1087     .24    +S130G
+S130G   1109     .09
$
$ --- SHAPE LOWER SKIN FOR QUADRATIC CHORDWISE
SHAPE    140     CQDMEM1 1003     .84    1005     .58    1007     .39    +S140A
+S140A   1009     .21    1011     .07    1013     .007   1015     .007   +S140B
+S140B   1023     .92    1025     .71    1027     .46    1029     .24    +S140C
+S140C   1031     .07    1045     .71    1047     .46    1049     .24    +S140D
+S140D   1051     .07    1067     .64    1069     .31    1071     .08    +S140E
+S140E   1073     .005   1089     .48    1091     .13    1093     .009   +S140F
+S140F   1111     .27    1113     .023   1131     .59    1133     .08
$
SHAPE    140     CTRMEM  1043     .90    1065     .93    1087     .88    +S140G
+S140G   1109     .79
```

```
$
$ - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
$
$ --- SHAPE UPPER SKIN FOR CONSTANT
SHAPE    200     CQDMEM1 1204    1.0     1206    1.0     1208    1.0     +S200A
+S200A   1210    1.0     1212    1.0     1214    1.0     1216    1.0     +S200B
+S200B   1224    1.0     1226    1.0     1228    1.0     1230    1.0     +S200C
+S200C   1232    1.0     1246    1.0     1248    1.0     1250    1.0     +S200D
+S200D   1252    1.0     1268    1.0     1270    1.0     1272    1.0     +S200E
+S200E   1274    1.0     1290    1.0     1292    1.0     1294    1.0     +S200F
+S200F   1312    1.0     1314    1.0     1332    1.0     1334    1.0
$
SHAPE    200     CTRMEM  1244    1.0     1266    1.0     1288    1.0     +S200G
+S200G   1310    1.0
$
$ --- SHAPE UPPER SKIN FOR LINEAR SPANWISE
SHAPE    210     CQDMEM1 1204    .93     1206    .93     1208    .93     +S210A
+S210A   1210    .93     1212    .93     1214    .93     1216    .93     +S210B
+S210B   1224    .80     1226    .80     1228    .80     1230    .80     +S210C
+S210C   1232    .80     1246    .73     1248    .73     1250    .73     +S210D
+S210D   1252    .73     1268    .64     1270    .64     1272    .64     +S210E
+S210E   1274    .64     1290    .49     1292    .49     1294    .49     +S210F
+S210F   1312    .30     1314    .30     1332    .09     1334    .09
$
SHAPE    210     CTRMEM  1244    .73     1266    .64     1288    .49     +S210G
+S210G   1310    .30
$
$ --- SHAPE UPPER SKIN FOR LINEAR CHORDWISE
SHAPE    220     CQDMEM1 1204    .91     1206    .76     1208    .62     +S220A
+S220A   1210    .45     1212    .26     1214    .09     1216    .09     +S220B
+S220B   1224    .96     1226    .84     1228    .68     1230    .49     +S220C
+S220C   1232    .26     1246    .84     1248    .68     1250    .49     +S220D
+S220D   1252    .26     1268    .80     1270    .56     1272    .28     +S220E
+S220E   1274    .074    1290    .69     1292    .36     1294    .10     +S220F
+S220F   1312    .52     1314    .15     1332    .77     1334    .28
$
SHAPE    220     CTRMEM  1244    .95     1266    .96     1288    .94     +S220G
+S220G   1310    .89
$
$ --- SHAPE UPPER SKIN FOR QUADRATIC SPANWISE
SHAPE    230     CQDMEM1 1204    .86     1206    .86     [illegible] .86  +S230A
+S230A   1210    .86     1212    .86     1214    .86     1216    .86     +S230B
+S230B   1224    .64     1226    .64     1228    .64     1230    .64     +S230C
+S230C   1232    .64     1246    .53     1248    .53     1250    .53     +S230D
+S230D   1252    .53     1268    .41     1270    .41     1272    .41     +S230E
+S230E   1274    .41     1290    .24     1292    .24     1294    .24     +S230F
+S230F   1312    .09     1314    .09     1332    .008    1334    .008
$
SHAPE    230     CTRMEM  1244    .53     1266    .41     1288    .24     +S230G
+S230G   1310    .09
$
$ --- SHAPE UPPER SKIN FOR QUADRATIC CHORDWISE
SHAPE    240     CQDMEM1 1204    .84     1206    .58     1208    .39     +S240A
+S240A   1210    .21     1212    .07     1214    .007    1216    .007    +S240B
```

```
+S240B   1224     .92     1226     .71     1228     .46     1230     .24     +S240C
+S240C   1232     .07     1246     .71     1248     .46     1250     .24     +S240D
+S240D   1252     .07     1268     .64     1270     .31     1272     .08     +S240E
+S240E   1274     .005    1290     .48     1292     .13     1294     .009    +S240F
+S240F   1312     .27     1314     .023    1332     .59     1334     .08
$
SHAPE    240      CTRMEM  1244     .90     1266     .93     1288     .88     +S240G
+S240G   1310     .79
$ - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
$
$ --- SHAPE RIBS  INBD PAIR ( 1 & 2 )
SHAPE    500      CQUAD4  1502     1.0     1503     1.0     1504     1.0     +S500A
+S500A   1505     1.0     1506     1.0     1507     1.0     1512     1.0     +S500B
+S500B   1513     1.0     1514     1.0     1515     1.0     1516     1.0     +S500C
+S500C   1517     1.0     1522     1.0
$
SHAPE    500      CTRIA3  1501     1.0     1508     1.0     1511     1.0     +S500G
+S500G   1518     1.0     1521     1.0
$
$ --- SHAPE RIBS  INTMEDIATE PAIR ( 3 & 4 )
SHAPE    510      CQUAD4  1532     1.0     1533     1.0     1534     1.0     +S510A
+S510A   1535     1.0     1536     1.0     1542     1.0     1543     1.0     +S510B
+S510B   1544     1.0     1545     1.0
$
SHAPE    510      CTRIA3  1531     1.0     1537     1.0     1541     1.0     +S510G
+S510G   1546     1.0
$
$ --- SHAPE RIBS  OUTBD THREE ( 5, 6 & 7 )
SHAPE    520      CQUAD4  1552     1.0     1553     1.0     1554     1.0     +S520A
+S520A   1562     1.0     1563     1.0     1572     1.0     1573     1.0
$
SHAPE    520      CTRIA3  1551     1.0     1555     1.0     1561     1.0     +S520G
+S520G   1564     1.0     1571     1.0     1574     1.0
$
$ - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
$
$ --- SHAPE SPARS  LEADING EDGE CONSTANT
SHAPE    600      CQUAD4  1601     1.0     1602     1.0     1603     1.0     +S600A
+S600A   1604     1.0     1605     1.0     1606     1.0     1607     1.0
$
$ --- SHAPE SPARS  LEADING EDGE  LINEAR
SHAPE    601      CQUAD4  1601     .92     1602     .81     1603     .75     +S601A
+S601A   1604     .65     1605     .49     1606     .29     1607     .094
$
$
$ --- SHAPE SPARS  1ST & 2ND INTERMEDIATE CONSTANT
SHAPE    610      CQUAD4  1611     1.0     1612     1.0     1613     1.0     +S610A
+S610A   1621     1.0     1622     1.0     1623     1.0     1624     1.0
$
$ --- SHAPE SPARS  1ST & 2ND INTERMEDIATE LINEAR
SHAPE    611      CQUAD4  1601     .72     1612     .34     1613     .10     +S611A
+S611A   1621     .82     1622     .56     1623     .27     1624     .18
$
$ --- SHAPE SPARS  3RD INTERMEDIATE CONSTANT
```

```
SHAPE    630     CQUAD4  1631    1.0     1632    1.0     1633    1.0     +S630A
+S630A   1634    1.0     1635    1.0
$
$ --- SHAPE SPARS  3RD INTERMEDIATE LINEAR
SHAPE    631     CQUAD4  1631     .85    1632     .68    1633     .56    +S631A
+S631A   1634     .38    1635     .15
$
$ --- SHAPE SPARS  4TH INTERMEDIATE CONSTANT
SHAPE    640     CQUAD4  1641    1.0     1642    1.0     1643    1.0     +S640A
+S640A   1644    1.0     1645    1.0     1646    1.0
$
$ --- SHAPE SPARS  4TH INTERMEDIATE LINEAR
SHAPE    641     CQUAD4  1641     .90    1642     .77    1643     .68    +S641A
+S641A   1644     .55    1645     .37    1646     .14
$
$ --- SHAPE SPARS  5TH INTERMEDIATE CONSTANT
SHAPE    650     CQUAD4  1651    1.0     1652    1.0     1653    1.0     +S650A
+S650A   1654    1.0     1655    1.0     1656    1.0     1657    1.0
$
$ --- SHAPE SPARS  5TH INTERMEDIATE LINEAR
SHAPE    651     CQUAD4  1651     .93    1652     .80    1653     .73    +S651A
+S651A   1654     .64    1655     .49    1656     .30    1657     .09
$
$ --- SHAPE SPARS  AT AILERON CONSTANT
SHAPE    660     CQUAD4  1661    1.0     1664    1.0     1665    1.0     +S660A
+S660A   1666    1.0     1667    1.0
$
$ --- SHAPE SPARS  AT AILERON LINEAR
SHAPE    661     CQUAD4  1661     .93    1664     .64    1665     .49    +S661A
+S661A   1666     .30    1667     .09
$
$ - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
$
$ --- SHAPE LEADING EGDE CONSTANT ( UPR & LWR SKIN )
SHAPE    700     CQDMEM1 1001    1.0     1021    1.0     1041    1.0     +S700A
+S700A   1061    1.0     1081    1.0     1101    1.0     1121    1.0     +S700B
+S700B   1202    1.0     1222    1.0     1242    1.0     1262    1.0     +S700C
+S700C   1282    1.0     1302    1.0     1322    1.0
$
$ --- SHAPE LEADING EDGE LINEAR
SHAPE    710     CQDMEM1 1001     .90    1021     .70    1041     .45    +S710A
+S710A   1061     .15    1081     .90    1101     .70    1121     .45    +S710B
+S710B   1202     .15    1222     .90    1242     .70    1262     .45    +S710C
+S710C   1282     .15    1302     .90    1322     .70
$
$ - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
$
$ --- SHAPE AILERON CONSTANT ( UPR & LWR SKIN  & SPAR )
SHAPE    800     CQDMEM1 1075    1.0     1095    1.0     1115    1.0     +S800A
+S800A   1135    1.0     1276    1.0     1296    1.0     1316    1.0     +S800B
+S800B   1336    1.0
SHAPE    800     CQUAD4  1674    1.0     1675    1.0     1676    1.0     +S800C
+S800C   1677    1.0
$
```

```
$ --- SHAPE AILERON LINEAR
SHAPE    810     CQDMEM1 1075    .90     1095    .70     1115    .45     +S810A
+S810A   1135    .15     1276    .90     1296    .70     1316    .45     +S810B
+S810B   1336    .15
SHAPE    810     CQUAD4  1674    .90     1675    .70     1676    .45     +S810C
+S810C   1677    .15
$
$DESVARS DVID---SHAPID--VMIN----VMAX----INIT----PLY-----PLYLIST LABEL
$
$ --- FWD FUSELAGE SKIN
$
$ --- FWD FUSELAGE  BOTTOM SKIN
DESVARS   2001    2001    -1000.  1000.   .07     1               FFBS0
DESVARS   2002    2002    -1000.  1000.   -.015   1               FFBS1
DESVARS   2003    2003    -1000.  1000.   -.014   1               FFBS2
$
$ --- FWD FUSELAGE SIDE SKIN
DESVARS   2011    2011    -1000.  1000.   .20     1               FFSS0
DESVARS   2012    2012    -1000.  1000.   .10     1               FFSS1
DESVARS   2013    2013    -1000.  1000.   .0      1               FFSS2
$
$ --- FWD FUSELAGE TOP SKIN FWD OF COCKPIT
DESVARS   2021    2021    -1000.  1000.   .12     1               FFTS0
DESVARS   2022    2022    -1000.  1000.   .0      1               FFTS1
$
$ --- FWD FUSELAGE TOP SKIN BEHIND COCKPIT
DESVARS   2171    2171    -1000.  1000.   .10     1               FFTSA0
DESVARS   2172    2172    -1000.  1000.   .0      1               FFTSA1
$
$ --- BHDS 175 195/201 228 245 269 282
DESVARS   2201    2201    -1000.  1000.   .10     1               BH175
DESVARS   2221    2221    -1000.  1000.   .10     1               BH195
DESVARS   2232    2232    -1000.  1000.   .10     1               BH228
DESVARS   2261    2261    -1000.  1000.   .13     1               BH269
DESVARS   2271    2271    -1000.  1000.   .10     1               BH282
$
$ --- FWD FUSELAGE FLOOR/NOSE WELL WALLS
DESVARS   2301    2301    -1000.  1000.   .10     1               FFFL0
DESVARS   2302    2302    -1000.  1000.   .03     1               FFFL1
DESVARS   2303    2303    -1000.  1000.   .03     1               FFFL2
$
$ --- FWD FUSELAGE LONGERONS
$ ---  LOWER
DESVARS   2501    2501    -1000.  1000.   .167    1               FFLL0
DESVARS   2502    2502    -1000.  1000.   .0      1               FFLL1
DESVARS   2503    2503    -1000.  1000.   .0      1               FFLL2
$ ---  UPPER
DESVARS   2521    2521    -1000.  1000.   .5      1               FFUL0
DESVARS   2522    2522    -1000.  1000.   .10     1               FFUL1
DESVARS   2523    2523    -1000.  1000.   .0      1               FFUL2
$
$
$ --- MID FUSELAGE SKINS
$
```

```
$ ---  MID BOTTOM SKIN
DESVARS   3001   3001    -1000.  1000.   .067    1               MFBS0
DESVARS   3002   3002    -1000.  1000.  -.016    1               MFBS1
DESVARS   3003   3003    -1000.  1000.  -.005    1               MFBS2
$
$ ---  MID SIDE SKIN
DESVARS   3011   3011    -1000.  1000.   .058    1               MFSS0
DESVARS   3012   3012    -1000.  1000.  -.016    1               MFSS1
DESVARS   3013   3013    -1000.  1000.   .0      1               MFSS2
$
$ ---  MID TOP SKIN
DESVARS   3021   3021    -1000.  1000.   .079    1               MFTS0
DESVARS   3022   3022    -1000.  1000.   .003    1               MFTS1
DESVARS   3023   3023    -1000.  1000.   .011    1               MFTS2
$
$ --- BHD/FRM 330 360 390 420 454 475
DESVARS   3121   3121    -1000.  1000.   .10     1               BH330
DESVARS   3141   3141    -1000.  1000.   .10     1               BH360
DESVARS   3161   3161    -1000.  1000.   .10     1               BH390
DESVARS   3191   3191    -1000.  1000.   .10     1               BH420
DESVARS   3221   3221    -1000.  1000.   .10     1               BH454
DESVARS   3251   3251    -1000.  1000.   .15     1               BH475
$
$ --- FUEL TANK FLOOR
DESVARS   3271   3271    -1000.  1000.   .086    1               MFFL0
DESVARS   3272   3272    -1000.  1000.   .02     1               MFFL1
$
$ --- INLET SKIN
DESVARS   3301   3301    -1000.  1000.   .076    1               INFS0
DESVARS   3302   3302    -1000.  1000.   .024    1               INFS1
$
$ --- INLET FRMS
DESVARS   3361   3361    -1000.  1000.   .10     1               INFR1
DESVARS   3381   3381    -1000.  1000.   .10     1               INFR2
DESVARS   3401   3401    -1000.  1000.   .15     1               INFR3
$
$ --- MID FUSELAGE LONGERONS
$ ---      LOWER
DESVARS   3501   3501    -1000.  1000.   .17     1               MFLL0
DESVARS   3502   3502    -1000.  1000.   .0      1               MFLL1
$
$ ---      UPPER
DESVARS   3511   3511    -1000.  1000.   .17     1               MFUL0
DESVARS   3512   3512    -1000.  1000.   .0      1               MFUL1
$
$ ---      DORSAL
DESVARS   3521   3521    -1000.  1000.   .15     1               MFDL0
DESVARS   3522   3522    -1000.  1000.   .0      1               MFDL1
$
$ ---      INLET   LOWER
DESVARS   3551   3551    -1000.  1000.   .15     1               INLL0
DESVARS   3552   3552    -1000.  1000.   .0      1               INLL1
$
$ ---      INLET   UPPER
```

```
DESVARS   3561   3561    -1000.  1000.   .15     1              INUL0
DESVARS   3562   3562    -1000.  1000.   .0      1              INUL1
$
$ --- END OF MID FUSELAGE LONGERONS
$
$ ---     RALS DUCT TUNNEL
DESVARS   3801   3801    -1000.  1000.   .047    1              RALS0
DESVARS   3802   3802    -1000.  1000.   .0      1              RALS1
$
$ ---     INLET INNER SKIN
DESVARS   3901   3901    -1000.  1000.   .042    1              INSK0
DESVARS   3902   3902    -1000.  1000.   .018    1              INSK1
$
$ --- AFT FUSELAGE
$ ---    BOT SKIN
DESVARS   4001   4001    -1000.  1000.   .047    1              AFBS0
DESVARS   4002   4002    -1000.  1000.   .0      1              AFBS1
DESVARS   4003   4003    -1000.  1000.   .0      1              AFBS2
$
$ ---    SIDE SKIN
DESVARS   4011   4011    -1000.  1000.   .064    1              AFSS0
DESVARS   4012   4012    -1000.  1000.   .0      1              AFSS1
DESVARS   4013   4013    -1000.  1000.   .0      1              AFSS2
$
$ ---    TOP SKIN
DESVARS   4021   4021    -1000.  1000.   .062    1              AFTS0
DESVARS   4022   4022    -1000.  1000.  -.015    1              AFTS1
DESVARS   4023   4023    -1000.  1000.   .0      1              AFTS2
$
$ --- BHD 495
DESVARS   4101   4101    -1000.  1000.   .33     1             BH495-0
DESVARS   4102   4102    -1000.  1000.   .0      1             BH495-1
DESVARS   4103   4103    -1000.  1000.   .0      1             BH495-2
$
$ --- FRM 520
DESVARS   4121   4121    -1000.  1000.   .27     1             FR520
$
$ --- BHD 545
DESVARS   4141   4141    -1000.  1000.   .40     1             BH545-0
DESVARS   4142   4142    -1000.  1000.   .0      1             BH545-1
DESVARS   4143   4143    -1000.  1000.   .0      1             BH545-2
$
$ --- BHD 581
DESVARS   4161   4161    -1000.  1000.   .52     1             BH581-0
DESVARS   4162   4162    -1000.  1000.   .0      1             BH581-1
DESVARS   4163   4163    -1000.  1000.   .0      1             BH581-2
$
$ --- BHD 615
DESVARS   4181   4181    -1000.  1000.   .32     1             BH615-0
DESVARS   4182   4182    -1000.  1000.   .0      1             BH615-1
DESVARS   4183   4183    -1000.  1000.   .0      1             BH615-2
$
$ --- FRM 649
DESVARS   4201   4201    -1000.  1000.   .10     1             FR649
```

```
$
$ --- AFT FUSELAGE LONGERONS
$ ---   LOWER
DESVARS    4501    4501     -1000.  1000.    .15      1              AFLLO
DESVARS    4502    4502     -1000.  1000.    .0       1              AFLL1
$
$ ---   UPPER
DESVARS    4511    4511     -1000.  1000.    .15      1              AFULO
DESVARS    4512    4512     -1000.  1000.    .0       1              AFUL1
$
$ ---    WING LUG LOWER STIFFENER
DESVARS    4531    4531     -1000.  1000.    .15      1              AFWLLO
DESVARS    4532    4532     -1000.  1000.    .0       1              AFWLL1
$
$ ---    WING LUG UPPER STIFFENER
DESVARS    4541    4541     -1000.  1000.    .15      1              AFWULO
DESVARS    4542    4542     -1000.  1000.    .0       1              AFWUL1
$
$ --- POD SKINS
DESVARS    5001    5001     -1000.  1000.    .11      1              PODS
DESVARS    5002    5002     -1000.  1000.   -.014     1              PODSX
$$DESVARS    5003    5003     -1000.  1000.   -.019     1              PODSXX
$$DESVARS    5004    5004     -1000.  1000.   -.028     1              PODSZ
$
$ --- POD BHDS
DESVARS    5201    5201     -1000.  1000.    .10      1              PBHD1
DESVARS    5241    5241     -1000.  1000.    .15      1              PBHD2
DESVARS    5281    5281     -1000.  1000.    .07      1              PBHD3
DESVARS    5341    5341     -1000.  1000.    .09      1              PBHD4
$
$ --- POD RODS    TOP/BOT  &  SIDE
DESVARS    5501    5501     -1000.  1000.    .15      1              PTOPR
DESVARS    5521    5521     -1000.  1000.    .15      1              PSIDER
$
$ - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
$ --- FUSELAGE / POD  SHAPES
$
SHAPE          2001CQUAD4        2001 1.00000     2002 1.00000     2003 1.00000+A
+A             2022 1.00000      2023 1.00000     2042 1.00000     2043 1.00000+A2
+A2            2062 1.00000      2063 1.00000     2082 1.00000     2083 1.00000+A3
+A3            2102 1.00000      2103 1.00000     2112 1.00000     2113 1.00000+A4
+A4            2122 1.00000      2123 1.00000     2131 1.00000     2132 1.00000+A5
+A5            2133 1.00000      2151 1.00000     2152 1.00000     2153 1.00000+A6
+A6            2161 1.00000      2162 1.00000     2163 1.00000
$
SHAPE          2002CQUAD4        2001 0.04649     2002 0.04649     2003 0.04649+A
+A             2022 0.11625      2023 0.11625     2042 0.16274     2043 0.16274+A2
+A2            2062 0.23333      2063 0.23333     2082 0.32772     2083 0.32772+A3
+A3            2102 0.43298      2103 0.43298     2112 0.52660     2113 0.52660+A4
+A4            2122 0.60993      2123 0.60993     2131 0.70519     2132 0.70519+A5
+A5            2133 0.70519      2151 0.83239     2152 0.83239     2153 0.83239+A6
+A6            2161 1.00000      2162 1.00000     2163 1.00000
$
SHAPE          2003CQUAD4        2001 0.00216     2002 0.00216     2003 0.00216+A
```

```
+A        2022 0.01351    2023 0.01351    2042 0.02648    2043 0.02648+A2
+A2       2062 0.05444    2063 0.05444    2082 0.10740    2083 0.10740+A3
+A3       2102 0.18747    2103 0.18747    2112 0.27730    2113 0.27730+A4
+A4       2122 0.37201    2123 0.37201    2131 0.49730    2132 0.49730+A5
+A5       2133 0.49730    2151 0.69287    2152 0.69287    2153 0.69287+A6
+A6       2161 1.00000    2162 1.00000    2163 1.00000
$
SHAPE     2011CQUAD4      2004 1.00000    2005 1.00000    2006 1.00000+A
+A        2007 1.00000    2044 1.00000    2045 1.00000    2046 1.00000+A2
+A2       2047 1.00000    2048 1.00000    2064 1.00000    2065 1.00000+A3
+A3       2066 1.00000    2068 1.00000    2084 1.00000    2085 1.00000+A4
+A4       2086 1.00000    2087 1.00000    2088 1.00000    2104 1.00000+A5
+A5       2105 1.00000    2106 1.00000    2107 1.00000    2108 1.00000+A6
+A6       2114 1.00000    2115 1.00000    2116 1.00000    2117 1.00000+A7
+A7       2118 1.00000    2124 1.00000    2126 1.00000    2127 1.00000+A8
+A8       2128 1.00000    2134 1.00000    2135 1.00000    2136 1.00000+A9
+A9       2137 1.00000    2146 1.00000    2147 1.00000    2154 1.00000+A10
+A10      2155 1.00000    2156 1.00000    2157 1.00000    2164 1.00000+A11
+A11      2165 1.00000    2166 1.00000    2167 1.00000
$
SHAPE     2011CTRIA3      2008 1.00000    2024 1.00000    2067 1.00000+A
+A        2125 1.00000    2145 1.00000
$
SHAPE     2012CQUAD4      2004 0.04649    2005 0.04649    2006 0.04649+A
+A        2007 0.04649    2044 0.15111    2045 0.13947    2046 0.13947+A2
+A2       2047 0.13947    2048 0.13947    2064 0.23333    2065 0.23333+A3
+A3       2066 0.23333    2068 0.23333    2084 0.32772    2085 0.32772+A4
+A4       2086 0.32772    2087 0.32772    2088 0.32772    2104 0.43298+A5
+A5       2105 0.43298    2106 0.43298    2107 0.43298    2108 0.43298+A6
+A6       2114 0.52660    2115 0.52660    2116 0.52660    2117 0.52660+A7
+A7       2118 0.52660    2124 0.60993    2126 0.60993    2127 0.60993+A8
+A8       2128 0.60993    2134 0.70519    2135 0.70519    2136 0.70519+A9
+A9       2137 0.70519    2146 0.78097    2147 0.80125    2154 0.83239+A10
+A10      2155 0.84153    2156 0.86086    2157 0.88114    2164 1.00000+A11
+A11      2165 1.00000    2166 1.00000    2167 1.00000
$
SHAPE     2012CTRIA3      2008 0.06199    2024 0.10849    2067 0.21754+A
+A        2125 0.59394    2145 0.76468
$
SHAPE     2013CQUAD4      2004 0.00216    2005 0.00216    2006 0.00216+A
+A        2007 0.00216    2044 0.02283    2045 0.01945    2046 0.01945+A2
+A2       2047 0.01945    2048 0.01945    2064 0.05444    2065 0.05444+A3
+A3       2066 0.05444    2068 0.05444    2084 0.10740    2085 0.10740+A4
+A4       2086 0.10740    2087 0.10740    2088 0.10740    2104 0.18747+A5
+A5       2105 0.18747    2106 0.18747    2107 0.18747    2108 0.18747+A6
+A6       2114 0.27730    2115 0.27730    2116 0.27730    2117 0.27730+A7
+A7       2118 0.27730    2124 0.37201    2126 0.37201    2127 0.37201+A8
+A8       2128 0.37201    2134 0.49730    2135 0.49730    2136 0.49730+A9
+A9       2137 0.49730    2146 0.60991    2147 0.64199    2154 0.69287+A10
+A10      2155 0.70817    2156 0.74108    2157 0.77641    2164 1.00000+A11
+A11      2165 1.00000    2166 1.00000    2167 1.00000
$
SHAPE     2013CTRIA3      2008 0.00384    2024 0.01177    2067 0.04732+A
+A        2125 0.35276    2145 0.58473
```

```
$
SHAPE     2021CQUAD4    2009 1.00000    2010 1.00000    2049 1.00000+A
+A        2050 1.00000  2069 1.00000    2070 1.00000    2090 1.00000
SHAPE     2021CTRIA3    2089 1.00000
$
SHAPE     2022CQUAD4    2009 0.13539    2010 0.13539    2049 0.40617+A
+A        2050 0.40617  2069 0.67950    2070 0.65395    2090 0.92882
SHAPE     2022CTRIA3    2089 1.00000
$
SHAPE     2171CQUAD4    2171 1.00000    2172 1.00000    2173 1.00000+A
+A        2174 1.00000  2175 1.00000    2176 1.00000
$
SHAPE     2172CQUAD4    2171 0.89123    2172 0.89123    2173 0.89123+A
+A        2174 1.00000  2175 1.00000    2176 1.00000
$
SHAPE     2201CQUAD4    2201 1.00000    2202 1.00000    2204 1.00000+A
+A        2205 1.00000  2206 1.00000    2207 1.00000    2208 1.00000+A2
+A2       2209 1.00000  2210 1.00000    2211 1.00000    2212 1.00000+A3
+A3       2213 1.00000  2214 1.00000
$
SHAPE     2201CTRIA3    2203 1.00000    2215 1.00000
$
SHAPE     2221CQUAD4    2221 1.00000    2223 1.00000
$
SHAPE     2221CTRIA3    2222 1.00000    2224 1.00000
$
SHAPE     2232CQUAD4    2232 1.00000    2235 1.00000    2236 1.00000+A
+A        2237 1.00000  2238 1.00000    2239 1.00000    2240 1.00000+A2
+A2       2241 1.00000  2242 1.00000    2243 1.00000    2244 1.00000+A3
+A3       2245 1.00000  2246 1.00000    2247 1.00000    2252 1.00000
$
SHAPE     2232CTRIA3    2233 1.00000    2248  5.        2253 1.00000
$
SHAPE     2261CQUAD4    2261 1.00000    2262 1.00000    2263 1.00000+A
+A        2264 1.00000  2265 1.00000    2266 1.00000
$
SHAPE     2261CTRIA3    2263 1.00000
$
SHAPE     2271CQUAD4    2271 1.00000    2272 1.00000    2273 1.00000+A
+A        2274 1.00000  2275 1.00000    2276 1.00000    2277 1.00000+A2
+A2       2278 1.00000  2279 1.00000    2280 1.00000    2281 1.00000+A3
+A3       2282 1.00000  2283 1.00000    2284 1.00000    2285 1.00000
$
SHAPE     2271CTRIA3    2273 1.00000
$
SHAPE     2301CQUAD4    2301 1.00000    2302 1.00000    2303 1.00000+A
+A        2304 1.00000  2305 1.00000    2306 1.00000    2307 1.00000+A2
+A2       2308 1.00000  2309 1.00000    2310 1.00000    2311 1.00000+A3
+A3       2312 1.00000  2313 1.00000    2314 1.00000    2315 1.00000+A4
+A4       2316 1.00000  2317 1.00000    2318 1.00000    2321 1.00000+A5
+A5       2322 1.00000  2323 1.00000    2324 1.00000    2325 1.00000+A6
+A6       2326 1.00000  2327 1.00000    2328 1.00000    2329 1.00000+A7
+A7       2331 1.00000  2332 1.00000    2333 1.00000    2334 1.00000+A8
+A8       2335 1.00000  2336 1.00000    2337 1.00000    2338 1.00000+A9
```

```
+A9     2341 1.00000   2342 1.00000   2343 1.00000   2344 1.00000+A10
+A10    2345 1.00000   2346 1.00000   2347 1.00000   2348 1.00000+A11
+A11    2349 1.00000   2350 1.00000   2351 1.00000   2352 1.00000+A12
+A12    2354 1.00000   2355 1.00000   2356 1.00000   2357 1.00000+A13
+A13    2358 1.00000   2359 1.00000   2361 1.00000
$
SHAPE   2301CTRIA3     2353 1.00000   2360 1.00000
$
SHAPE   2302CQUAD4     2301 0.06593   2302 0.06593   2303 0.16484+A
+A      2304 0.16484   2305 0.23077   2306 0.23077   2307 0.33088+A2
+A2     2308 0.33088   2309 0.46472   2310 0.46472   2311 0.61399+A3
+A3     2312 0.61399   2313 0.74674   2314 0.74674   2315 0.86491+A4
+A4     2316 0.86491   2317 1.00000   2318 1.00000   2321 0.61399+A5
+A5     2322 0.61399   2323 0.74674   2324 0.74674   2325 0.86491+A6
+A6     2326 0.86491   2327 1.00000   2328 1.00000   2329 1.00000+A7
+A7     2331 0.06593   2332 0.16484   2333 0.23077   2334 0.33088+A8
+A8     2335 0.46472   2336 0.61399   2337 0.74674   2338 0.86491+A9
+A9     2341 0.06593   2342 0.06593   2343 0.16484   2344 0.16484+A10
+A10    2345 0.23077   2346 0.23077   2347 0.33088   2348 0.33088+A11
+A11    2349 0.46472   2350 0.46472   2351 0.61399   2352 0.61399+A12
+A12    2354 0.61399   2355 0.74674   2356 0.74674   2357 0.74674+A13
+A13    2358 0.86491   2359 0.86491   2361 1.00000
$
SHAPE   2302CTRIA3     2353 0.58646   2360 0.84224
$
SHAPE   2303CQUAD4     2301 0.00435   2302 0.00435   2303 0.02717+A
+A      2304 0.02717   2305 0.05325   2306 0.05325   2307 0.10948+A2
+A2     2308 0.10948   2309 0.21597   2310 0.21597   2311 0.37699+A3
+A3     2312 0.37699   2313 0.55762   2314 0.55762   2315 0.74807+A4
+A4     2316 0.74807   2317 1.00000   2318 1.00000   2321 0.37699+A5
+A5     2322 0.37699   2323 0.55762   2324 0.55762   2325 0.74807+A6
+A6     2326 0.74807   2327 1.00000   2328 1.00000   2329 1.00000+A7
+A7     2331 0.00435   2332 0.02717   2333 0.05325   2334 0.10948+A8
+A8     2335 0.21597   2336 0.37699   2337 0.55762   2338 0.74807+A9
+A9     2341 0.00435   2342 0.00435   2343 0.02717   2344 0.02717+A10
+A10    2345 0.05325   2346 0.05325   2347 0.10948   2348 0.10948+A11
+A11    2349 0.21597   2350 0.21597   2351 0.37699   2352 0.37699+A12
+A12    2354 0.37699   2355 0.55762   2356 0.55762   2357 0.55762+A13
+A13    2358 0.74807   2359 0.74807   2361 1.00000
$
SHAPE   2303CTRIA3     2353 0.34393   2360 0.70936
$
SHAPE   2501CROD       2501 1.00000   2502 1.00000   2503 1.00000+A
+A      2504 1.00000   2505 1.00000   2506 1.00000   2507 1.00000+A2
+A2     2508 1.00000   2509 1.00000   2510 1.00000   2511 1.00000
$
SHAPE   2502CROD       2501 0.04649   2502 0.11625   2503 0.16274+A
+A      2504 0.23333   2505 0.32772   2506 0.43298   2507 0.52660+A2
+A2     2508 0.60993   2509 0.70519   2510 0.83239   2511 1.00000
$
SHAPE   2503CROD       2501 0.002     2502 0.02      2503 0.06    +A
+A      2504 0.10      2505 0.16      2506 0.24      2507 0.36    +A2
+A2     2508 0.50      2509 0.65      2510 0.80      2511 1.00000
$
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```
SHAPE   2521CROD     2521 1.00000   2522 1.00000   2523 1.00000+A
+A      2524 1.00000 2525 1.00000   2526 1.00000   2527  3.     +A2
+A2     2528 1.00000 2529 1.00000   2530 1.00000   2531 1.00000
$
SHAPE   2522CROD     2521 0.04649   2522 0.13947   2523 0.23333+A
+A      2524 0.32772 2525 0.43298   2526 0.52660   2527 0.60993+A2
+A2     2528 0.70519 2529 0.81133   2530 0.89123   2531 1.00000
$
SHAPE   2523CROD     2521 0.002     2522 0.02      2523 0.06    +A
+A      2524 0.10    2525 0.16      2526 0.24      2527 0.36    +A2
+A2     2528 0.50    2529 0.65      2530 0.80      2531 1.00000
$
SHAPE   3001CQUAD4   3001 1.00000   3002 1.00000   3003 1.00000+A
+A      3004 1.00000 3021 1.00000   3022 1.00000   3023 1.00000+A2
+A2     3024 1.00000 3041 1.00000   3042 1.00000   3043 1.00000+A3
+A3     3044 1.00000 3061 1.00000   3062 1.00000   3063 1.00000+A4
+A4     3064 1.00000 3081 1.00000   3082 1.00000   3083 1.00000+A5
+A5     3084 1.00000 3101 1.00000   3102 1.00000   3103 1.00000+A6
+A6     3104 1.00000
$
SHAPE   3002CQUAD4   3001 0.09670   3002 0.09670   3003 0.09670+A
+A      3004 0.09670 3021 0.29009   3022 0.29009   3023 0.29009+A2
+A2     3024 0.29009 3041 0.48348   3042 0.48348   3043 0.48348+A3
+A3     3044 0.48348 3061 0.68977   3062 0.68977   3063 0.68977+A4
+A4     3064 0.68977 3081 0.86624   3082 0.86624   3083 0.86624+A5
+A5     3084 0.86624 3101 1.00000   3102 1.00000   3103 1.00000+A6
+A6     3104 1.00000
$
SHAPE   3003CQUAD4   3001 0.00935   3002 0.00935   3003 0.00935+A
+A      3004 0.00935 3021 0.08415   3022 0.08415   3023 0.08415+A2
+A2     3024 0.08415 3041 0.23375   3042 0.23375   3043 0.23375+A3
+A3     3044 0.23375 3061 0.47578   3062 0.47578   3063 0.47578+A4
+A4     3064 0.47578 3081 0.75037   3082 0.75037   3083 0.75037+A5
+A5     3084 0.75037 3101 1.00000   3102 1.00000   3103 1.00000+A6
+A6     3104 1.00000
$
SHAPE   3011CQUAD4   3005 1.00000   3006 1.00000   3007 1.00000+A
+A      3025 1.00000 3026 1.00000   3027 1.00000   3045 1.00000+A2
+A2     3046 1.00000 3047 1.00000   3048 1.00000   3049 1.00000+A3
+A3     3051 1.00000 3052 1.00000   3066 1.00000   3067 1.00000+A4
+A4     3068 1.00000 3069 1.00000   3070 1.00000   3085 1.00000+A5
+A5     3086 1.00000 3087 1.00000   3088 1.00000   3089 1.00000+A6
+A6     3105 1.00000 3106 1.00000   3107 1.00000   3108 1.00000+A7
+A7     3109 1.00000
$
SHAPE   3011CTRIA3   3050 1.00000   3065 1.00000   3071 1.00000
$
SHAPE   3012CQUAD4   3005 0.09670   3006 0.09670   3007 0.09670+A
+A      3025 0.29009 3026 0.29009   3027 0.29009   3045 0.48348+A2
+A2     3046 0.48348 3047 0.48348   3048 0.48348   3049 0.48348+A3
+A3     3051 0.48348 3052 0.48348   3066 0.68977   3067 0.68977+A4
+A4     3068 0.68977 3069 0.68977   3070 0.68977   3085 0.86624+A5
+A5     3086 0.86624 3087 0.86624   3088 0.86624   3089 0.86624+A6
+A6     3105 1.00000 3106 1.00000   3107 1.00000   3108 1.00000+A7
```

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+A7     3109 1.00000
$
SHAPE   3012CTRIA3   3050 0.45125   3065 0.65323   3071 0.65323
$
SHAPE   3013CQUAD4   3005 0.00935   3006 0.00935   3007 0.00935+A
+A      3025 0.08415 3026 0.08415   3027 0.08415   3045 0.23375+A2
+A2     3046 0.23375 3047 0.23375   3048 0.23375   3049 0.23375+A3
+A3     3051 0.23375 3052 0.23375   3066 0.47578   3067 0.47578+A4
+A4     3068 0.47578 3069 0.47578   3070 0.47578   3085 0.75037+A5
+A5     3086 0.75037 3087 0.75037   3088 0.75037   3089 0.75037+A6
+A6     3105 1.00000 3106 1.00000   3107 1.00000   3108 1.00000+A7
+A7     3109 1.00000
$
SHAPE   3013CTRIA3   3050 0.20362   3065 0.42671   3071 0.42671
$
SHAPE   3021CQUAD4   3008 1.00000   3009 1.00000   3010 1.00000+A
+A      3028 1.00000 3029 1.00000   3030 1.00000   3053 1.00000+A2
+A2     3054 1.00000 3055 1.00000   3072 1.00000   3073 1.00000+A3
+A3     3074 1.00000 3090 1.00000   3091 1.00000   3092 1.00000+A4
+A4     3110 1.00000 3111 1.00000   3112 1.00000
$
SHAPE   3022CQUAD4   3008 0.09670   3009 0.09670   3010 0.09670+A
+A      3028 0.29009 3029 0.29009   3030 0.29009   3053 0.48348+A2
+A2     3054 0.48348 3055 0.48348   3072 0.68977   3073 0.68977+A3
+A3     3074 0.68977 3090 0.86624   3091 0.86624   3092 0.86624+A4
+A4     3110 1.00000 3111 1.00000   3112 1.00000
$
SHAPE   3023CQUAD4   3008 0.00935   3009 0.00935   3010 0.00935+A
+A      3028 0.08415 3029 0.08415   3030 0.08415   3053 0.23375+A2
+A2     3054 0.23375 3055 0.23375   3072 0.47578   3073 0.47578+A3
+A3     3074 0.47578 3090 0.75037   3091 0.75037   3092 0.75037+A4
+A4     3110 1.00000 3111 1.00000   3112 1.00000
$
SHAPE   3121CQUAD4   3121 1.00000   3122 1.00000   3123 1.00000+A
+A      3124 1.00000 3125 1.00000   3126 1.00000   3127 1.00000+A2
+A2     3129 1.00000 3130 1.00000   3131 1.00000   3132 1.00000+A3
+A3     3133 1.00000 3134 1.00000   3136 1.00000   3137 1.00000+A4
+A4     3138 1.00000
$
SHAPE   3121CTRIA3   3128 1.00000   3135 1.00000
$
SHAPE   3141CQUAD4   3141 1.00000   3142 1.00000   3143 1.00000+A
+A      3144 1.00000 3145 1.00000   3146 1.00000   3147 1.00000+A2
+A2     3148 1.00000 3149 1.00000   3151 1.00000
$
SHAPE   3141CTRIA3   3150 1.00000
$
SHAPE   3161CQUAD4   3161 1.00000   3162 1.00000   3163 1.00000+A
+A      3164 1.00000 3165 1.00000   3166 1.00000   3167 1.00000+A2
+A2     3168 1.00000 3169 1.00000   3170 1.00000   3171 1.00000+A3
+A3     3172 1.00000 3173 1.00000   3174 1.00000   3175 1.00000+A4
+A4     3176 1.00000 3177 1.00000   3178 1.00000   3179 1.00000+A5
+A5     3180 1.00000 3181 1.00000   3182 1.00000   3183 1.00000+A6
+A6     3184 1.00000 3185 1.00000   3186 1.00000   3187 1.00000+A7
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+A7	3188 1.00000			
SHAPE	3161CTRIA3	3181 1.00000		
$				
SHAPE	3191CQUAD4	3191 1.00000	3192 1.00000	3193 1.00000+A
+A	3194 1.00000	3195 1.00000	3196 1.00000	3197 1.00000+A2
+A2	3198 1.00000	3199 1.00000	3200 1.00000	3201 1.00000+A3
+A3	3203 1.00000	3204 1.00000	3205 1.00000	3206 1.00000+A4
+A4	3208 1.00000	3209 1.00000	3210 1.00000	
$				
SHAPE	3191CTRIA3	3202 1.00000	3207 1.00000	
$				
SHAPE	3221CQUAD4	3221 1.00000	3222 1.00000	3223 1.00000+A
+A	3225 1.00000	3226 1.00000	3227 1.00000	3228 1.00000+A2
+A2	3229 1.00000	3230 1.00000	3232 1.00000	3233 1.00000+A3
+A3	3234 1.00000	3235 1.00000	3236 1.00000	3238 1.00000+A4
+A4	3239 1.00000	3240 1.00000		
$				
SHAPE	3221CTRIA3	3224 1.00000	3231 1.00000	3237 1.00000
$				
SHAPE	3251CQUAD4	3251 1.00000	3252 1.00000	3253 1.00000+A
+A	3254 1.00000	3255 1.00000	3256 1.00000	3257 1.00000+A2
+A2	3258 1.00000	3259 1.00000	3260 1.00000	3261 1.00000+A3
+A3	3262 1.00000			
SHAPE	3251CTRIA3	3253 1.00000		
$				
SHAPE	3271CQUAD4	3271 1.00000	3272 1.00000	3273 1.00000+A
+A	3274 1.00000	3275 1.00000	3276 1.00000	3277 1.00000+A2
+A2	3279 1.00000	3280 1.00000	3281 1.00000	
$				
SHAPE	3271CTRIA3	3278 1.00000	3282 1.00000	3283 1.00000
$				
SHAPE	3272CQUAD4	3271 0.14019	3272 0.14019	3273 0.14019+A
+A	3274 0.42056	3275 0.42056	3276 0.42056	3277 0.70093+A2
+A2	3279 0.70093	3280 0.70093	3281 1.00000	
$				
SHAPE	3272CTRIA3	3278 0.65420	3282 0.94704	3283 0.94704
$				
SHAPE	3301CQUAD4	3304 1.00000	3305 1.00000	3306 1.00000+A
+A	3311 1.00000	3312 1.00000	3313 1.00000	3314 1.00000+A2
+A2	3315 1.00000	3316 1.00000	3317 1.00000	3318 1.00000+A3
+A3	3319 1.00000	3320 1.00000	3321 1.00000	3322 1.00000+A4
+A4	3323 1.00000	3331 1.00000	3332 1.00000	3333 1.00000+A5
+A5	3334 1.00000	3335 1.00000	3336 1.00000	3337 1.00000+A6
+A6	3338 1.00000	3339 1.00000	3340 1.00000	3341 1.00000+A7
+A7	3342 1.00000	3343 1.00000	3352 1.00000	3353 1.00000+A8
+A8	3354 1.00000	3355 1.00000	3356 1.00000	3357 1.00000+A9
+A9	3358 1.00000	3359 1.00000	3303 1.0	
$				
SHAPE	3301CTRIA3	3301 1.00000	3302 1.00000	3307 1.00000+A
+A	3308 1.00000	3351 1.00000		
$				
SHAPE	3302CQUAD4	3304 0.13806	3305 0.23170	3306 0.28274+A
+A	3311 0.42414	3312 0.42414	3313 0.42055	3314 0.39985+A2
+A2	3315 0.36560	3316 0.33291	3317 0.31394	3318 0.30964+A3

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+A3     3319 0.30871    3320 0.31220    3321 0.34178    3322 0.39387+A4
+A4     3323 0.42203    3331 0.64200    3332 0.64200    3333 0.64200+A5
+A5     3334 0.64200    3335 0.64200    3336 0.64200    3337 0.64200+A6
+A6     3338 0.64200    3339 0.64200    3340 0.64200    3341 0.64200+A7
+A7     3342 0.64200    3343 0.64200    3352 1.00000    3353 1.00000+A8
+A8     3354 1.00000    3355 1.00000    3356 1.00000    3357 1.00000+A9
+A9     3358 1.00000    3359 1.00000    3303  .138
$
SHAPE   3302CTRIA3      3301 0.10207    3302 0.10084    3307 0.31766+A
+A      3308 0.31766    3351 0.93827
$
SHAPE   3361CQUAD4      3361 1.00000    3362 1.00000    3363 1.00000+A
+A      3364 1.00000    3365 1.00000    3366 1.00000    3367 1.00000+A2
+A2     3368 1.00000    3369 1.00000    3370 1.00000    3371 1.00000+A3
+A3     3372 1.00000    3373 1.00000
$
SHAPE   3381CQUAD4      3381 1.00000    3382 1.00000    3383 1.00000+A
+A      3384 1.00000    3385 1.00000    3386 1.00000    3387 1.00000+A2
+A2     3388 1.00000    3389 1.00000    3390 1.00000    3391 1.00000
$
SHAPE   3401CQUAD4      3401 1.00000    3402 1.00000    3403 1.00000+A
+A      3404 1.00000    3405 1.00000    3406 1.00000    3407 1.00000+A2
+A2     3408 1.00000    3409 1.00000    3410 1.00000    3411 1.00000
$
SHAPE   3501CROD        3501 1.00000    3502 1.00000    3503 1.00000+A
+A      3504 1.00000    3505 1.00000    3506 1.00000
$
SHAPE   3502CROD        3501 0.09670    3502 0.29009    3503 0.48348+A
+A      3504 0.68977    3505 0.86624    3506 1.00000
$
SHAPE   3511CROD        3511 1.00000    3512 1.00000    3513 1.00000+A
+A      3514 1.00000    3515 1.00000    3516 1.00000
$
SHAPE   3512CROD        3511 0.09670    3512 0.29009    3513 0.48348+A
+A      3514 0.68977    3515 0.86624    3516 1.00000
$
SHAPE   3521CROD        3521 1.00000    3522 1.00000    3523 1.00000+A
+A      3524 1.00000    3525 1.00000    3526 1.00000    4521 1.00000
$
SHAPE   3522CROD        3521 0.08433    3522 0.25299    3523 0.42164+A
+A      3524 0.60155    3525 0.75545    3526 0.87210    4521 1.00000
$
SHAPE   3551CROD        3551 1.00000    3552 1.00000    3553 1.00000+A
+A      3554 1.00000    3555 1.00000    3556 1.00000    3557 1.00000
$
SHAPE   3552CROD        3551 0.05251    3552 0.15043    3553 0.30620+A
+A      3554 0.48348    3555 0.68977    3556 0.86624    3557 1.00000
$
SHAPE   3561CROD        3561 1.00000    3562 1.00000    3563 1.00000+A
+A      3564 1.00000    3565 1.00000    3566 1.00000    3567 1.00000
$
SHAPE   3562CROD        3561 0.00917    3562 0.15043    3563 0.30620+A
+A      3564 0.48348    3565 0.68977    3566 0.86624    3567 1.00000
$
```

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SHAPE   3801CQUAD4  3801 1.00000  3802 1.00000  3803 1.00000+A
+A      3804 1.00000  3805 1.00000  3811 1.00000  3812 1.00000+A2
+A2     3813 1.00000  3814 1.00000  3815 1.00000  3816 1.00000+A3
+A3     3817 1.00000  3818 1.00000  3821 1.00000  3822 1.00000+A4
+A4     3823 1.00000  3824 1.00000  3825 1.00000  3826 1.00000+A5
+A5     3827 1.00000  3828 1.00000  3831 1.00000  3832 1.00000+A6
+A6     3833 1.00000  3834 1.00000  3835 1.00000  3836 1.00000+A7
+A7     3837 1.00000  3838 1.00000  3851 1.00000  3852 1.00000+A8
+A8     3853 1.00000  3854 1.00000
$
SHAPE   3801CTRIA3  3815 1.00000
$
SHAPE   3802CQUAD4  3801 0.14019  3802 0.14019  3803 0.14019+A
+A      3804 0.14019  3805 0.14019  3811 0.42056  3812 0.42056+A2
+A2     3813 0.42056  3814 0.42056  3815 0.46729  3816 0.42056+A3
+A3     3817 0.42056  3818 0.42056  3821 0.70093  3822 0.70093+A4
+A4     3823 0.70093  3824 0.70093  3825 0.70093  3826 0.70093+A5
+A5     3827 0.70093  3828 0.70093  3831 1.00000  3832 1.00000+A6
+A6     3833 1.00000  3834 1.00000  3835 1.00000  3836 1.00000+A7
+A7     3837 1.00000  3838 1.00000  3851 0.42056  3852 0.42056+A8
+A8     3853 0.70093  3854 1.00000
$
SHAPE   3802CTRIA3  3815 1.00000
$
SHAPE   3901CQUAD4  3902 1.00000  3903 1.00000  3911 1.00000+A
+A      3912 1.00000  3913 1.00000  3914 1.00000  3915 1.00000+A2
+A2     3916 1.00000  3917 1.00000  3918 1.00000  3919 1.00000+A3
+A3     3921 1.00000  3922 1.00000  3923 1.00000  3924 1.00000+A4
+A4     3925 1.00000  3926 1.00000  3927 1.00000  3928 1.00000+A5
+A5     3929 1.00000  3931 1.00000  3932 1.00000  3933 1.00000+A6
+A6     3934 1.00000  3935 1.00000  3936 1.00000  3937 1.00000+A7
+A7     3938 1.00000  3939 1.00000  3943 1.00000  3944 1.00000+A8
+A8     3945 1.00000  3946 1.00000  3948 1.00000  3950 1.00000+A9
+A9     3951 1.00000  3961 1.00000  3962 1.00000  3963 1.00000+A10
+A10    3964 1.00000  3965 1.00000  3966 1.00000  3967 1.00000+A11
+A11    3968 1.00000  3969 1.00000  3970 1.00000  3971 1.00000+A12
+A12    3972 1.00000  3973 1.00000  3974 1.00000  3975 1.00000+A13
+A13    3976 1.00000  3977 1.00000  3978 1.00000  3979 1.00000+A14
+A14    3980 1.00000  3981 1.00000  3982 1.00000  3983 1.00000+A15
+A15    3984 1.00000  3985 1.00000  3986 1.00000  3987 1.00000+A16
+A16    3988 1.00000  3941 1.00000
$
SHAPE   3901CTRIA3  3901 1.00000  3904 1.00000  3942 1.00000+A
+A      3947 1.00000  3949 1.00000
$
SHAPE   3902CQUAD4  3902-0.06819  3903-0.02784  3911 0.05298+A
+A      3912 0.05016  3913 0.04232  3914 0.02996  3915 0.01805+A2
+A2     3916 0.01133  3917 0.00893  3918 0.01960  3919 0.04205+A3
+A3     3921 0.14899  3922 0.14899  3923 0.14899  3924 0.14899+A4
+A4     3925 0.14899  3926 0.14899  3927 0.14899  3928 0.14899+A5
+A5     3929 0.14899  3931 0.30327  3932 0.30327  3933 0.30327+A6
+A6     3934 0.30327  3935 0.30327  3936 0.30327  3937 0.30327+A7
+A7     3938 0.30327  3939 0.30327  3943 0.47885  3944 0.47885+A8
+A8     3945 0.47885  3946 0.47885  3948 0.47885  3950 0.47885+A9
```

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+A9         3951 0.47885    3961 0.68316    3962 0.68316    3963 0.68316+A10
+A10        3964 0.68316    3965 0.68316    3966 0.68316    3967 0.68316+A11
+A11        3968 0.68316    3969 0.68316    3970 0.68316    3971 0.85794+A12
+A12        3972 0.85794    3973 0.85794    3974 0.85794    3975 0.85794+A13
+A13        3976 0.85794    3977 0.85794    3978 0.85794    3979 0.85794+A14
+A14        3980 0.85794    3981 1.00000    3982 1.00000    3983 1.00000+A15
+A15        3984 1.00000    3985 1.00000    3986 1.00000    3987 1.00000+A16
+A16        3988 1.00000    3941 0.47885
$
SHAPE       3902CTRIA3      3901-0.07744    3904 0.00518    3942 0.51077+A
+A          3947 0.44692    3949 0.51077
$
SHAPE       4001CQUAD4      4001 1.00000    4002 1.00000    4003 1.00000+A
+A          4021 1.00000    4022 1.00000    4023 1.00000    4041 1.00000+A2
+A2         4042 1.00000    4043 1.00000    4061 1.00000    4062 1.00000+A3
+A3         4063 1.00000    4081 1.00000    4082 1.00000    4083 1.00000
$
SHAPE       4002CQUAD4      4001 0.09415    4002 0.09415    4003 0.09415+A
+A          4021 0.27514    4022 0.27514    4023 0.27514    4041 0.49726+A2
+A2         4042 0.49726    4043 0.49726    4061 0.75320    4062 0.75320+A3
+A3         4063 0.75320    4081 1.00000    4082 1.00000    4083 1.00000
$
SHAPE       4003CQUAD4      4001 0.00886    4002 0.00886    4003 0.00886+A
+A          4021 0.07570    4022 0.07570    4023 0.07570    4041 0.24727+A2
+A2         4042 0.24727    4043 0.24727    4061 0.56731    4062 0.56731+A3
+A3         4063 0.56731    4081 1.00000    4082 1.00000    4083 1.00000
$
SHAPE       4011CQUAD4      4004 1.00000    4005 1.00000    4006 1.00000+A
+A          4007 1.00000    4008 1.00000    4009 1.00000    4024 1.00000+A2
+A2         4025 1.00000    4026 1.00000    4027 1.00000    4028 1.00000+A3
+A3         4029 1.00000    4044 1.00000    4045 1.00000    4046 1.00000+A4
+A4         4047 1.00000    4048 1.00000    4049 1.00000    4064 1.00000+A5
+A5         4065 1.00000    4066 1.00000    4067 1.00000    4068 1.00000+A6
+A6         4069 1.00000    4084 1.00000    4085 1.00000    4086 1.00000+A7
+A7         4087 1.00000    4088 1.00000    4089 1.00000
$
SHAPE       4012CQUAD4      4004 0.09415    4005 0.09415    4006 0.09415+A
+A          4007 0.09415    4008 0.09415    4009 0.09415    4024 0.27514+A2
+A2         4025 0.27514    4026 0.27514    4027 0.27514    4028 0.27514+A3
+A3         4029 0.27514    4044 0.49726    4045 0.49726    4046 0.49726+A4
+A4         4047 0.49726    4048 0.49726    4049 0.49726    4064 0.75320+A5
+A5         4065 0.75320    4066 0.75320    4067 0.75320    4068 0.75320+A6
+A6         4069 0.75320    4084 1.00000    4085 1.00000    4086 1.00000+A7
+A7         4087 1.00000    4088 1.00000    4089 1.00000
$
SHAPE       4013CQUAD4      4004 0.00886    4005 0.00886    4006 0.00886+A
+A          4007 0.00886    4008 0.00886    4009 0.00886    4024 0.07570+A2
+A2         4025 0.07570    4026 0.07570    4027 0.07570    4028 0.07570+A3
+A3         4029 0.07570    4044 0.24727    4045 0.24727    4046 0.24727+A4
+A4         4047 0.24727    4048 0.24727    4049 0.24727    4064 0.56731+A5
+A5         4065 0.56731    4066 0.56731    4067 0.56731    4068 0.56731+A6
+A6         4069 0.56731    4084 1.00000    4085 1.00000    4086 1.00000+A7
+A7         4087 1.00000    4088 1.00000    4089 1.00000
$
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SHAPE     4021CQUAD4    4010 1.00000    4011 1.00000    4012 1.00000+A
+A        4030 1.00000  4031 1.00000    4032 1.00000    4050 1.00000+A2
+A2       4051 1.00000  4052 1.00000    4070 1.00000    4071 1.00000+A3
+A3       4072 1.00000  4090 1.00000    4091 1.00000    4092 1.00000
$
SHAPE     4022CQUAD4    4010 0.09415    4011 0.09415    4012 0.09415+A
+A        4030 0.27514  4031 0.27514    4032 0.27514    4050 0.49726+A2
+A2       4051 0.49726  4052 0.49726    4070 0.75320    4071 0.75320+A3
+A3       4072 0.75320  4090 1.00000    4091 1.00000    4092 1.00000
$
SHAPE     4023CQUAD4    4010 0.00886    4011 0.00886    4012 0.00886+A
+A        4030 0.07570  4031 0.07570    4032 0.07570    4050 0.24727+A2
+A2       4051 0.24727  4052 0.24727    4070 0.56731    4071 0.56731+A3
+A3       4072 0.56731  4090 1.00000    4091 1.00000    4092 1.00000
$
SHAPE     4101CQUAD4    4101 1.00000    4102 1.00000    4103 1.00000+A
+A        4104 1.00000  4105 1.00000    4106 1.00000    4107 1.00000+A2
+A2       4108 1.00000  4109 1.00000    4110 1.00000    4111 1.00000+A3
+A3       4112 1.00000  4113 1.00000
$
SHAPE     4102CQUAD4    4101 0.03461    4102 0.05038    4103 0.13586+A
+A        4104 0.15665  4105 0.25544    4106 0.36937    4107 0.46080+A2
+A2       4108 0.58401  4109 0.74024    4110 0.86418    4111 0.93653+A3
+A3       4112 0.98257  4113 1.00000
$
SHAPE     4103CQUAD4    4101 0.00120    4102 0.00254    4103 0.01846+A
+A        4104 0.02454  4105 0.06525    4106 0.13643    4107 0.21234+A2
+A2       4108 0.34107  4109 0.54796    4110 0.74680    4111 0.87708+A3
+A3       4112 0.96543  4113 1.00000
$
SHAPE     4121CQUAD4    4121 1.00000    4122 1.00000    4123 1.00000+A
+A        4124 1.00000  4125 1.00000    4126 1.00000    4127 1.00000+A2
+A2       4128 1.00000  4129 1.00000    4130 1.00000    4131 1.00000+A3
+A3       4132 1.00000
$
SHAPE     4141CQUAD4    4141 1.00000    4142 1.00000    4143 1.00000+A
+A        4144 1.00000  4145 1.00000    4146 1.00000    4147 1.00000+A2
+A2       4148 1.00000  4149 1.00000    4150 1.00000    4151 1.00000+A3
+A3       4152 1.00000
$
SHAPE     4142CQUAD4    4141 0.04951    4142 0.06472    4143 0.11243+A
+A        4144 0.20076  4145 0.32129    4146 0.45799    4147 0.58755+A2
+A2       4148 0.71857  4149 0.84204    4150 0.93058    4151 0.98152+A3
+A3       4152 1.00000
$
SHAPE     4143CQUAD4    4141 0.00245    4142 0.00419    4143 0.01264+A
+A        4144 0.04031  4145 0.10323    4146 0.20975    4147 0.34522+A2
+A2       4148 0.51634  4149 0.70904    4150 0.86598    4151 0.96338+A3
+A3       4152 1.00000
$
SHAPE     4161CQUAD4    4161 1.00000    4162 1.00000    4163 1.00000+A
+A        4164 1.00000  4165 1.00000    4166 1.00000    4167 1.00000+A2
+A2       4168 1.00000  4169 1.00000    4170 1.00000    4171 1.00000+A3
+A3       4172 1.00000
```

```
$
SHAPE   4162CQUAD4  4161 0.08539  4162 0.09549  4163 0.13554+A
+A      4164 0.21797  4165 0.33822  4166 0.47759  4167 0.60360+A2
+A2     4168 0.72364  4169 0.85153  4170 0.94545  4171 0.98728+A3
+A3     4172 1.00000
$
SHAPE   4163CQUAD4  4161 0.00729  4162 0.00912  4163 0.01837+A
+A      4164 0.04751  4165 0.11439  4166 0.22809  4167 0.36433+A2
+A2     4168 0.52365  4169 0.72510  4170 0.89387  4171 0.97472+A3
+A3     4172 1.00000
$
SHAPE   4181CQUAD4  4181 1.00000  4182 1.00000  4183 1.00000+A
+A      4184 1.00000  4185 1.00000  4186 1.00000  4187 1.00000+A2
+A2     4188 1.00000  4189 1.00000  4190 1.00000  4191 1.00000+A3
+A3     4192 1.00000
$
SHAPE   4182CQUAD4  4181 0.15519  4182 0.16183  4183 0.19055+A
+A      4184 0.25864  4185 0.37101  4186 0.51159  4187 0.63703+A2
+A2     4188 0.76079  4189 0.87968  4190 0.95185  4191 0.98801+A3
+A3     4192 1.00000
$
SHAPE   4183CQUAD4  4181 0.02408  4182 0.02619  4183 0.03631+A
+A      4184 0.06690  4185 0.13765  4186 0.26172  4187 0.40581+A2
+A2     4188 0.57881  4189 0.77384  4190 0.90602  4191 0.97616+A3
+A3     4192 1.00000
$
SHAPE   4201CQUAD4  4201 1.00000  4202 1.00000  4203 1.00000+A
+A      4204 1.00000  4205 1.00000  4206 1.00000  4207 1.00000+A2
+A2     4208 1.00000  4209 1.00000  4210 1.00000  4211 1.00000+A3
+A3     4212 1.00000
$
SHAPE   4501CROD    4501 1.00000  4502 1.00000  4503 1.00000+A
+A      4504 1.00000  4505 1.00000
$
SHAPE   4502CROD    4501 0.09415  4502 0.27514  4503 0.49726+A
+A      4504 0.75320  4505 1.00000
$
SHAPE   4511CROD    4511 1.00000  4512 1.00000  4513 1.00000+A
+A      4514 1.00000  4515 1.00000
$
SHAPE   4512CROD    4511 0.09415  4512 0.27514  4513 0.49726+A
+A      4514 0.75320  4515 1.00000
$
SHAPE   4531CROD    4531 1.00000  4532 1.00000  4533 1.00000+A
+A      4534 1.00000
$
SHAPE   4532CROD    4531 0.12500  4532 0.36529  4533 0.66019+A
+A      4534 1.00000
$
SHAPE   4541CROD    4541 1.00000  4542 1.00000  4543 1.00000+A
+A      4544 1.00000
$
SHAPE   4542CROD    4541 0.12500  4542 0.36529  4543 0.66019+A
+A      4544 1.00000
```

```
$
SHAPE   5001CQUAD4  5001 1.00000  5002 1.00000  5003 1.00000+A
+A      5004 1.00000  5005 1.00000  5006 1.00000  5021 1.00000+A2
+A2     5022 1.00000  5023 1.00000  5024 1.00000  5025 1.00000+A3
+A3     5026 1.00000  5027 1.00000  5028 1.00000  5029 1.00000+A4
+A4     5030 1.00000  5041 1.00000  5042 1.00000  5043 1.00000+A5
+A5     5044 1.00000  5045 1.00000  5046 1.00000  5047 1.00000+A6
+A6     5048 1.00000  5049 1.00000  5050 1.00000  5061 1.00000+A7
+A7     5062 1.00000  5063 1.00000  5064 1.00000  5065 1.00000+A8
+A8     5066 1.00000  5067 1.00000  5068 1.00000  5069 1.00000+A9
+A9     5070 1.00000  5081 1.00000  5082 1.00000  5083 1.00000+A10
+A10    5084 1.00000  5085 1.00000  5086 1.00000  5087 1.00000+A11
+A11    5088 1.00000  5089 1.00000  5090 1.00000  5101 1.00000+A12
+A12    5102 1.00000  5103 1.00000  5104 1.00000  5105 1.00000+A13
+A13    5106 1.00000  5107 1.00000  5108 1.00000  5109 1.00000+A14
+A14    5110 1.00000  5121 1.00000  5122 1.00000  5123 1.00000+A15
+A15    5124 1.00000  5125 1.00000  5126 1.00000  5127 1.00000+A16
+A16    5128 1.00000  5129 1.00000  5130 1.00000  5141 1.00000+A17
+A17    5142 1.00000  5143 1.00000  5144 1.00000  5145 1.00000+A18
+A18    5146 1.00000  5147 1.00000  5148 1.00000  5149 1.00000+A19
+A19    5150 1.00000
$
SHAPE   5002CQUAD4  5001 0.09091  5002 0.09091  5003 0.09091+A
+A      5004 0.09091  5005 0.09091  5006 0.09091  5021 0.26768+A2
+A2     5022 0.26768  5023 0.26768  5024 0.26768  5025 0.26768+A3
+A3     5026 0.26768  5027 0.26768  5028 0.26768  5029 0.26768+A4
+A4     5030 0.26768  5041 0.39899  5042 0.39899  5043 0.39899+A5
+A5     5044 0.39899  5045 0.39899  5046 0.39899  5047 0.39899+A6
+A6     5048 0.39899  5049 0.39899  5050 0.39899  5061 0.50000+A7
+A7     5062 0.50000  5063 0.50000  5064 0.50000  5065 0.50000+A8
+A8     5066 0.50000  5067 0.50000  5068 0.50000  5069 0.50000+A9
+A9     5070 0.50000  5081 0.61869  5082 0.61869  5083 0.61869+A10
+A10    5084 0.61869  5085 0.61869  5086 0.61869  5087 0.61869+A11
+A11    5088 0.61869  5089 0.61869  5090 0.61869  5101 0.71970+A12
+A12    5102 0.71970  5103 0.71970  5104 0.71970  5105 0.71970+A13
+A13    5106 0.71970  5107 0.71970  5108 0.71970  5109 0.71970+A14
+A14    5110 0.71970  5121 0.85859  5122 0.85859  5123 0.85859+A15
+A15    5124 0.85859  5125 0.85859  5126 0.85859  5127 0.85859+A16
+A16    5128 0.85859  5129 0.85859  5130 0.85859  5141 1.00000+A17
+A17    5142 1.00000  5143 1.00000  5144 1.00000  5145 1.00000+A18
+A18    5146 1.00000  5147 1.00000  5148 1.00000  5149 1.00000+A19
+A19    5150 1.00000
$
SHAPE   5003CQUAD4  5001 0.00826  5002 0.00826  5003 0.00826+A
+A      5004 0.00826  5005 0.00826  5006 0.00826  5021 0.07165+A2
+A2     5022 0.07165  5023 0.07165  5024 0.07165  5025 0.07165+A3
+A3     5026 0.07165  5027 0.07165  5028 0.07165  5029 0.07165+A4
+A4     5030 0.07165  5041 0.15919  5042 0.15919  5043 0.15919+A5
+A5     5044 0.15919  5045 0.15919  5046 0.15919  5047 0.15919+A6
+A6     5048 0.15919  5049 0.15919  5050 0.15919  5061 0.25000+A7
+A7     5062 0.25000  5063 0.25000  5064 0.25000  5065 0.25000+A8
+A8     5066 0.25000  5067 0.25000  5068 0.25000  5069 0.25000+A9
+A9     5070 0.25000  5081 0.38277  5082 0.38277  5083 0.38277+A10
+A10    5084 0.38277  5085 0.38277  5086 0.38277  5087 0.38277+A11
```

```
+A11    5088 0.38277    5089 0.38277    5090 0.38277    5101 0.51796+A12
+A12    5102 0.51796    5103 0.51796    5104 0.51796    5105 0.51796+A13
+A13    5106 0.51796    5107 0.51796    5108 0.51796    5109 0.51796+A14
+A14    5110 0.51796    5121 0.73717    5122 0.73717    5123 0.73717+A15
+A15    5124 0.73717    5125 0.73717    5126 0.73717    5127 0.73717+A16
+A16    5128 0.73717    5129 0.73717    5130 0.73717    5141 1.00000+A17
+A17    5142 1.00000    5143 1.00000    5144 1.00000    5145 1.00000+A18
+A18    5146 1.00000    5147 1.00000    5148 1.00000    5149 1.00000+A19
+A19    5150 1.00000
$
SHAPE   5004CQUAD4      5001 0.04063    5002-0.32239    5003-0.51969+A
+A      5004-0.52547    5005-0.34668    5006-0.03100    5021 0.03171+A2
+A2     5022-0.46518    5023-0.79022    5024-0.80405    5025-0.51585+A3
+A3     5026-0.06068    5027 0.69902    5028 0.92085    5029 0.93997+A4
+A4     5030 0.78555    5041 0.04356    5042-0.50064    5043-0.87688+A5
+A5     5044-0.89250    5045-0.55300    5046-0.04858    5047 0.67051+A6
+A6     5048 0.96576    5049 0.98673    5050 0.75377    5061 0.05104+A7
+A7     5062-0.50034    5063-0.87950    5064-0.88755    5065-0.52707+A8
+A8     5066 0.00418    5067 0.61735    5068 0.95763    5069 0.96926+A9
+A9     5070 0.66030    5081 0.07000    5082-0.46395    5083-0.82199+A10
+A10    5084-0.82224    5085-0.46476    5086 0.06861    5087 0.59258+A11
+A11    5088 0.95119    5089 0.95164    5090 0.59387    5101 0.11440+A12
+A12    5102-0.39057    5103-0.72275    5104-0.72275    5105-0.39047+A13
+A13    5106 0.11448    5107 0.61570    5108 0.95812    5109 0.95812+A14
+A14    5110 0.61571    5121 0.25714    5122-0.17685    5123-0.45983+A15
+A15    5124-0.45947    5125-0.17601    5126 0.25771    5127 0.68940+A16
+A16    5128 0.97728    5129 0.97723    5130 0.68925    5141 0.43561+A17
+A17    5142 0.09300    5143-0.12995    5144-0.12954    5145 0.09377+A18
+A18    5146 0.43609    5147 0.77939    5148 1.00000    5149 0.99992+A19
+A19    5150 0.77920
$
SHAPE   5201CQUAD4      5201 1.00000    5206 1.00000    5221 1.00000+A
+A      5222 1.00000    5223 1.00000    5224 1.00000
$
SHAPE   5201CTRIA3      5202 1.00000    5203 1.00000    5204 1.00000+A
+A      5205 1.00000    5225 1.00000    5226 1.00000    5227 1.00000+A2
+A2     5228 1.00000
$
SHAPE   5241CQUAD4      5241 1.00000    5242 1.00000    5243 1.00000+A
+A      5244 1.00000    5245 1.00000    5246 1.00000    5261 1.00000+A2
+A2     5262 1.00000    5263 1.00000    5264 1.00000    5265 1.00000+A3
+A3     5266 1.00000
$
SHAPE   5281CQUAD4      5281 1.00000    5282 1.00000    5283 1.00000+A
+A      5284 1.00000    5285 1.00000    5286 1.00000    5301 1.00000+A2
+A2     5302 1.00000    5303 1.00000    5304 1.00000    5305 1.00000+A3
+A3     5306 1.00000    5321 1.00000    5322 1.00000    5323 1.00000+A4
+A4     5324 1.00000    5325 1.00000    5326 1.00000
$
SHAPE   5341CQUAD4      5341 1.00000    5342 1.00000    5343 1.00000+A
+A      5344 1.00000    5345 1.00000    5346 1.00000    5361 1.00000+A2
+A2     5362 1.00000    5363 1.00000    5364 1.00000    5365 1.00000+A3
+A3     5366 1.00000
$
```

```
SHAPE        5501CROD        5502 1.00000    5503 1.00000    5504 1.00000+A
+A           5505 1.00000    5506 1.00000    5507 1.00000    5508 1.00000+A2
+A2          5511 1.00000    5512 1.00000    5513 1.00000    5514 1.00000+A3
+A3          5515 1.00000    5516 1.         5517 1.         5518 1.
$
SHAPE        5521CROD        5522 1.00000    5523 1.00000    5524 1.00000+A
+A           5525 1.00000    5526 1.00000    5527 1.00000    5528 1.00000+A2
+A2          5532 1.00000    5533 1.00000    5534 1.00000    5535 1.     +A3
+A3          5536 1.00000    5537 1.         5538 1.
$
$ - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
$
$ --- EIGENSOLUTION DATA
$
$DYNRED-SID-----FMAX----NVEC----
DYNRED   440     15.     20
$
$EIGR---SID-----METH----FMIN----FMAX----NE------ND------
EIGR     440     INV     0.      15.     12      12
EIGR     441     GIV                             15
EIGR     442     MGIV                            12
$
$ --- OMITS ( NOT USED AS OF 1989-AUG-5 )
$
$OMIT---SID-----ID------C-------ID------C-------ID------C-------
OMIT     440     1073    456     1075    456     1076    456
OMIT     440     1115    45      1116    45
OMIT     440     1155    45      1156    45
$
$
$ - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
$
$ --- STEADY AERO DATA
$
$AEROS--AERCID--REFCID--REFC----REFB----REFS----GREF----REFD----REFL----
AEROS                    212.9   388.7   71280.  99
$
$AIRFOIL ACID---CMPNT---CP------ICHORD--IUST----ILST----ICAM----RADIUS--
AIRFOIL  10001   WING            1001    1002    1003            0.5     +AF1A
+AF1A    411.32  34.     7.65    266.21
$+AF1---X1------Y1------Z1------X12-----
$
AIRFOIL  10001   WING            1001    1002    1003            0.5     +AF1B
+AF1B    601.637 194.366 -6.38   55.94
$
$ --- PERCENT CHORD FOR WING AIRFOIL DEFN
$
AEFACT   1001    0.0     2.5     5.0     10.     15.0    20.     25.     +AE1001A
+AE1001A 30.     35.     40.     45.     50.     55.     60.     65.     +AE1001B
+AE1001B 70.     75.     80.     85.     90.     95.     100.
$
$ --- UPPER SURFACE PERCENT CHORD OFFSET FROM PLANE OF WING AIRFOIL
$
AEFACT   1002    0.0     .970    1.370   2.019   2.542   2.952   3.261   +AE1002A
```

```
+AE1002A  3.480    3.617    3.681    3.679    3.617    3.5      3.332     3.114 +AE1002B
+AE1002B  2.850    2.539    2.181    1.777    1.3417   0.9015 0.4624
$
$ --- LOWER SURFACE PERCENT CHORD OFFSET FROM PLANE OF WING AIRFOIL
$
AEFACT   1003     0.0      .4597    .5321    .6013    .6395    .6520    .6459 +AE1003A
+AE1003A   .6297    .6063   .5724    .5239    .4576    .3725    .2690    .1473 +AE1003B
+AE1003B   .0140   -.1162   -.2283 -.3082   -.3614   -.4112   -.4624
$
$CAERO6 ACID----CMPNT---CP------IGRP----LCHORD--LSPAN---
CAERO6   10001    WING              101      1011     1012
$
$
$ --- PERCENT CHORD CUTS FOR WING AERO PANELS     11 CUTS 10 PANELS
$
AEFACT   1011      0.0      5.0      10.     18.0      28.      43.0     58.    +AE1011A
+AE1011A   71.      82.      91.      100.
$
$ --- DIMENSIONED SPAN CUTS FOR WING AERO PANELS  11 CUTS 10 PANELS
$
AEFACT   1012      34.0     50.04    66.07    82.11    98.15   114.18   130.22 +AE1012A
+AE1012A 146.26   162.29   178.33   194.366
$
$ - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
$
$ --- CANARD AERO DEFINITION
$ ---  MOVED FORWARD 24 INCHES RELATIVE TO INITIAL DESIGN TO IMPROVE
$ ---   CONTROL EFFECTIVENESS
$AIRFOIL ACID---CMPNT---CP------ICHORD--IUST----ILST----ICAM----RADIUS--
AIRFOIL   12001  CANARD            1201     1202    1202              0.5     +AF2A
+AF2A     315.538  52.      23.135 102.892
$+AF2A     339.538  52.      23.135 102.892
$+AF----X1------Y1------Z1------X12-----
$
AIRFOIL   12001  CANARD            1201     1202    1202              0.5     +AF2B
+AF2B     402.248 102.062  26.62    27.982
$+AF2B     426.248 102.062  26.62    27.982
$
$ --- PERCENT CHORD FOR WING AIRFOIL DEFN
$
AEFACT   1201      0.0      2.       4.0      10.      20.0     30.      40.    +AE1201A
+AE1201A  50.      60.      70.      80.      90.      100.
$
$ --- SYMMETRIC SURFACE PERCENT CHORD OFFSET FROM PLANE OF CANARD AIRFOIL
$
AEFACT   1202      0.0       .993    1.274    1.663    1.899  1.981     1.999 +AE1202A
+AE1202A  1.921    1.715    1.393     .983     .515    0.0
$
$
$CAERO6 ACID ---CMPNT---CP------IGRP----LCHORD--LSPAN---
CAERO6   12001    CANARD            101      1211     1212
$
$
$ --- PERCENT CHORD CUTS FOR CANARD AERO PANELS      9 CUTS  8 PANELS
```

```
$
AEFACT   1211      0.0      6.0      12.      25.0      40.      55.0      70.    +AE1211A
+AE1211A  85.     100.
$
$ --- DIMENSIONED SPAN CUTS FOR CANARD AERO PANELS   8 CUTS   7 PANELS
$
AEFACT  1212      52.0     61.      66.      71.      81.      88.      95.    +AE1212A
+AE1212A 102.062
$
$ --- ATTACH CANARD AIRLOADS TO CANARD CENTER OF PRESSURE POINT - GRID 3138
$ATTACH-EID-----CAEROID-BOX1ST--BOXLAST-REFGID
ATTACH   12001   12001   12001   12056   3138
$
$
$ --- CONTROL SURFACE DEFINITION FOR CANARD 333
$
$ --- ASTROS VERSION 3 AESURF
$AESURF-SETID---LABEL---ACID1---CID1----FBOXID1-LBOXID1-
$AESURF   333     ELEV    12001           12001   12056
$
$ --- ASTROS VERSION 4 VERSION OF AESURF:
$AESURF-LABEL---SYMM----ACID1---CID1----FBOXID1-LBOXID1-
AESURF   ELEV    SYM     12001           12001   12056
$
$ --- CONTROL SURFACE DEFINITION FOR AILERON  444
$
$ --- ASTROS VERSION 3 AESURF
$AESURF-SETID---LABEL---ACID1---CID1----FBOXID1-LBOXID1-
$AESURF   444    AILERON  10001           10049   10100
$
$ --- ASTROS VERSION 4 VERSION OF AESURF:
$AESURF-LABEL---SYMM----ACID1---CID1----FBOXID1-LBOXID1-
AESURF   AILERON ANTISYM 10001           10049   10100
$
$ --- TRIM  CONDITIONS    ( QRATE = G(NZ-1)/V0  )
$ ---       SYMMETRIC PULLUP
$ ---  ASTROS VERSION 3 TRIM STYLE
$
$TRIM---TID-----MACH----QDP-----SYMXZ---TRMTYP--NZ------QRATE---V0------
$TRIM      74      .70      5.04    +1      2      -1737.  -.2265    9374.
$TRIM      84      .80      6.58    +1      2      -1737.  -.1982   10713.
$
$TRIM      71      .70      5.04    +1      2        386.   .0        9374.
$
$TRIM      70      .70      5.04    +1      2       5211.   .5147     9374.
$TRIM      80      .80      6.58    +1      2       5211.   .4504    10713.
$TRIM     120     1.20     14.82    +1      2       5211.   .3002    16070.
$TRIM     150     1.50     23.15    +1      2       5211.   .2402    20088.
$
$ ---  TRIM  CONDITIONS    ( QRATE = G(NZ-1)/V0  )
$ ---       SYMMETRIC PULLUP
$ --- ASTROS VERSION 4 TRIM STYLE
$
$TRIM---TID-----MACH----QDP-----TRMTYP--EFFID---V0--------------------+CONT
```

```
TRIM     70      .70      5.04    PITCH        9374.                         +TRIM
+TRIM    NZ      5211.   QRATE      .5147 ELEV    FREE    ALPHA      FREE   +TRIM
+TRIM    THKCAM  1.0
$
TRIM     71      .70      5.04    PITCH        9374.                         +TRIM
+TRIM    NZ      386.    QRATE    0.0     ELEV    FREE    ALPHA      FREE   +TRIM
+TRIM    THKCAM  1.0
$
TRIM     74      .70      5.04    PITCH        9374.                         +TRIM
+TRIM    NZ      -1737.  QRATE    -.2265  ELEV    FREE    ALPHA      FREE   +TRIM
+TRIM    THKCAM  1.0
$
$TRIM     150     1.50     23.15   PITCH        20088.                        +TRIM
$+TRIM    NZ      5211.   QRATE     .2402  ELEV    FREE    ALPHA      FREE   +TRIM
$+TRIM    THKCAM  1.0
$
$CONT---LABEL---VALUE---LABEL---VALUE---LABEL---VALUE---LABEL---VALUE---ETC
$
$ ---    SPLINE SET FOR STEADY AERO
$ ---      LOWER WING SURFACE GRIDS   3 SPLINES:
$ ---          INBOARD OF AILERON
$ ---          FORWARD OF AILERON
$ ---                     AILERON
$
$SPLINE1 EID----CP------CAERO---BOX1----BOX2----SETG----DZ------
SPLINE1  101             10001   10001   10040   101
SPLINE1  102             10001   10041   10098   102
SPLINE1  103             10001   10049   10100   103
$
$SET1---SID-----G1------G2------G3------G4------G5------G6------G7------
SET1     101     1001    1003    1005    1007    1009    1011    1013
SET1     101     1015    1017
SET1     101     1021    1023    1025    1027    1029    1031    1033
SET1     101     1035    1037
SET1     101     1041    1043    1045    1047    1049    1051    1053
SET1     101     1061    1065    1067    1069    1071    1073    1075
$
SET1     102     1061    1065    1067    1069    1071    1073    1075
SET1     102     1081    1087    1089    1091    1093    1095
SET1     102     1101    1109    1111    1113    1115
SET1     102     1121    1131    1133    1135
SET1     102     1141    1151    1153    1155
$
SET1     103     1077    1079
SET1     103     1097    1099
SET1     103     1117    1119
SET1     103     1137    1139
SET1     103     1157    1159
$
$ - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
$
$ --- DATA FOR BODY SEGMENT  1  FORWARD FUSELAGE
$
$PAERO6- BCID---CMPNT---CP------IGRP----NRAD----LRAD----LAXIAL--
```

```
PAERO6    100     FUSEL           101
BODY      100     FUSEL
$
$AXSTA--BCID----XSTA----CBOD----ABOD----LYRAD---LZRAD---
AXSTA    100     100.000                          101      151
AXSTA    100     130.000                          102      152
AXSTA    100     155.000                          103      153
AXSTA    100     185.000                          104      154
AXSTA    100     215.000                          105      155
AXSTA    100     245.000                          106      156
AXSTA    100     280.000                          107      157
AXSTA    100     305.000                          108      158
AXSTA    100     330.000                          109      159
$
$ --- STA 100 X AND Y
$
AEFACT       101  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000+101A
+101A     0.0000  0.0000
$
AEFACT       151-20.000 -20.000 -20.000 -20.000 -20.000 -20.000 -20.000 +151A
+151A    -20.000 -20.000
$
$ --- STA 130 X AND Y
$
AEFACT       102  0.0000  3.2340  6.1790  8.1660  8.4220  6.6570  4.6450+102A
+102A     2.3780  0.0000
$
AEFACT       152-21.6300-21.2360-19.8680-17.3250-14.1220-11.4360-10.1490+152A
+152A    -9.3890 -9.1330
$
$ --- STA 155 X AND Y
$
AEFACT       103  0.0000  5.3430 10.0710 12.6450 12.8600 10.7230  7.6520+103A
+103A     3.9300  0.0000
$
AEFACT       153-22.6940-22.0830-19.6090-14.9550 -9.5960 -4.7190 -2.2650+153A
+153A    -0.9640 -0.5880
$
$ --- STA 185 X AND Y
$
AEFACT       104  0.0000  7.3310 13.5490 16.1080 16.2570 14.0570 10.3350+104A
+104A     5.3730  0.0000
$
AEFACT       154-23.0790-22.3150-18.5810-11.7390 -4.3640  2.6260  6.5100+154A
+154A     8.6250  9.2150
$
$ --- STA 215 X AND Y
$
AEFACT       105  0.000   9.1000 16.3140 18.4110 18.3720 15.7980 11.6220+105A
+105A     6.1290  0.000
$
AEFACT       155-22.3490-21.4830-16.3150 -7.4620  1.6900 10.4160 15.0470+155A
+155A    18.0850 19.3020
$
```

```
$ --- STA 245 X AND Y
$
AEFACT       106  0.000  10.5680 18.1400 19.6540 19.4370 16.6660 14.6310+106A
+106A     8.5050  0.000
$
AEFACT       156-21.0360-20.0740-13.3340 -2.8400  7.7870 17.9970 26.5780+156A
+156A    32.9210 35.2520
$
$ --- STA 280 X AND Y
$
AEFACT       107  0.000  11.5160 18.9250 19.9710 19.8210 17.7600 18.2370+107A
+107A    11.4040  0.000
$
AEFACT       157-19.7340-18.8080-10.8940  0.6210 12.1940 23.5560 35.5690+157A
+157A    45.4600 49.2660
$
$ --- STA 305 X AND Y
$
AEFACT       108  0.000  12.3590 19.2440 19.9710 19.8210 18.0810 18.0210+108A
+108A    11.1200  0.000
$
AEFACT       158-19.5450-18.5630 -9.3200  3.0780 15.5030 27.7850 39.4740+158A
+158A    48.9090 52.5090
$
$ --- STA 330 X AND Y
$
AEFACT       109  0.000  13.4170 19.5440 19.9900 19.7730 17.7930 16.2140+109A
+109A     9.5980  0.000
$
AEFACT       159-19.8730-18.8680 -8.0340  5.4480 18.9450 32.2550 42.1240+159A
+159A    49.6140 52.3990
$
$ --- DATA FOR BODY SEGMENT  2   CENTER FUSELAGE FWD AT CANARD
$
$PAERO6- BCID---CMPNT---CP------IGRP----NRAD----LRAD----LAXIAL--
PAERO6    200    FUSEL           101
BODY      200    FUSEL
$
$AXSTA--BCID----XSTA----CBOD----ABOD----LYRAD---LZRAD---
AXSTA    200     330.000                 201     251
AXSTA    200     360.000                 202     252
AXSTA    200     390.000                 203     253
AXSTA    200     420.000                 204     254
AXSTA    200     445.000                 205     255
$
$ --- STA 330 X AND Y
$
AEFACT       201  0.000   6.8270 13.5800 18.3930 19.5730 31.3960 43.1990+201A
+201A    51.5170 51.9590 52.0010 44.2020 35.8500 27.4940 19.1380 17.5810+201B
+201B    11.3650  0.000
$
AEFACT       251-19.8730 19.7350-18.8210-14.4020 -7.6950 -7.6210 -6.9930+251A
+251A    -0.2590 11.5440 23.1350 25.5920 25.8140 25.8570 25.8580 37.9910+251B
+251B    48.3370 52.3990
```

```
$
$ --- STA 360 X AND Y
$
AEFACT       202  0.000   7.3130 14.5770 19.8660 20.9850 32.5750 44.1340+202A
+202A    51.4930 51.7900 52.0010 46.7580 37.9200 28.8650 19.8010 17.1440+202B
+202B     9.1630  0.000
$
AEFACT       252-20.5970-20.4870-19.7200-15.2380 -8.0300 -7.9290 -7.1700+252A
+252A     0.2580 11.8360 23.1350 30.1000 31.7990 32.1400 32.1930 38.9460+252B
+252B    47.4160 49.7740
$
$ --- STA 390 X AND Y
$
AEFACT       203  0.000   8.1070 16.1700 22.5000 24.0080 35.0540 45.9760+203A
+203A    49.6510 49.6410 52.0010 47.3020 40.1920 31.2140 22.1550 16.7580+203B
+203B     8.5960  0.000
$
AEFACT       253-21.5230-21.4050-20.6330-16.1740 -8.2420 -8.0960 -6.7850+253A
+253A     2.9400 13.9850 23.1350 29.5400 34.6330 35.7560 35.9890 42.5360+253B
+253B    45.5100 46.5670
$
$ --- STA 420 X AND Y
$
AEFACT       204  0.000   9.1530 18.2770 25.7950 27.4690 37.6840 45.3010+204A
+204A    45.9820 45.7990 52.0010 45.1050 41.9720 34.1870 25.5130 18.5510+204B
+204B     9.3200  0.000
$
AEFACT       254-22.4810-22.3820-21.7190-17.2780 -8.3260 -7.8240 -2.3730+254A
+254A     7.8180 18.0490 23.1350 25.7280 33.7270 37.2600 37.9970 43.6300+254B
+254B    44.8100 45.0000
$
$ --- STA 445 X AND Y
$
AEFACT       205  0.000   9.7640 19.4930 27.6170 29.5980 38.8840 42.1160+205A
+205A    42.2800 42.4980 52.0010 43.1990 40.4090 34.8810 26.2960 18.5400+205B
+205B     9.3110  0.000
$
AEFACT       255-23.1850-23.0680-22.3170-17.6550 -8.1550 -6.0220  2.7260+255A
+255A    12.3600 21.5260 23.1350 23.3850 30.6650 37.1560 38.9060 43.6430+255B
+255B    44.7920 44.9990
$
$ --- DATA FOR BODY SEGMENT  3   CENTER FUELAGE AFT AT WING
$
$PAERO6- BCID---CMPNT---CP------IGRP----NRAD----LRAD----LAXIAL--
PAERO6    300    FUSEL          101
BODY      300    FUSEL
$
$AXSTA--BCID----XSTA----CBOD----ABOD----LYRAD---LZRAD---
AXSTA   300     445.000                 301     351
AXSTA   300     470.000                 302     352
AXSTA   300     498.500                 303     353
$
$ --- STA 445 X AND Y
$
```

```
AEFACT       301  0.000   9.7640 19.4930 27.6170 29.5980 37.1990 41.6390+301A
+301A    41.5660 34.0000 42.2970 42.0860 40.9270 35.7330 26.2960 20.7710+301B
+301B    13.9520  6.9850  0.000
$
AEFACT       351-23.1850-23.0680-22.3170-17.6550 -8.1540 -6.9070 -1.0590+351A
+351A     6.0690  7.6500  9.3920 19.1490 28.8270 36.7270 38.9050 42.9790+351B
+351B    44.4190 44.8950 44.9990
$
$ --- STA 470 X AND Y
$
AEFACT       302  0.000  10.5430 21.0560 29.5710 31.2220 35.8780 37.9990+302A
+302A    38.5810 34.0000 38.6610 38.4390 37.5800 34.7660 28.0420 22.1110+302B
+302B    14.8250  7.4190  0.000
$
AEFACT       352-23.7000-23.5960-22.8860-17.6710 -7.3020 -4.6850  0.2440+352A
+352A     5.6340  7.6500 11.5620 19.5680 27.5260 34.9510 38.9680 43.1660+352B
+352B    44.4920 44.9110 45.0000
$
$ --- STA 498.5 X AND Y
$
AEFACT       303  0.000  11.7420 23.4490 31.4310 32.4000 33.8980 34.6840+303A
+303A    35.0670 34.0000 35.2090 34.9620 34.2580 32.4910 28.2100 22.2490+303B
+303B    14.9590  7.4910  0.000
$
AEFACT       353-23.9270-23.8250-23.0160-15.7770 -4.0880 -1.2870  1.7990+353A
+353A     4.9640  7.6500 13.6840 20.3360 26.9520 33.3510 38.2940 42.6480+353B
+353B    44.3010 44.8710 45.0000
$
$ --- DATA FOR BODY SEGMENT  4   AFT FUSELAGE
$
$PAERO6- BCID---CMPNT---CP------IGRP----NRAD----LRAD----LAXIAL--
PAERO6     400    FUSEL           101
BODY       400    FUSEL
$
$AXSTA--BCID----XSTA----CBOD----ABOD----LYRAD---LZRAD---
AXSTA    400      498.500                         401      451
AXSTA    400      530.000                         402      452
AXSTA    400      560.000                         403      453
AXSTA    400      590.000                         404      454
AXSTA    400      620.000                         405      455
AXSTA    400      650.000                         406      456
AXSTA    400      672.732                         407      457
$
$ --- STA 498.5 X AND Y
$
AEFACT       401  0.000  11.9000 23.7580 31.5220 32.7680 34.0000 34.9890+401A
+401A    32.9340 24.7020 12.5870  0.000
$
AEFACT       451-23.9270-23.8210-22.9620-15.3150 -3.5780  7.6500 19.8780+451A
+451A    32.2650 41.4780 44.5540 45.0000
$
$ --- STA 530.  X AND Y
$
AEFACT       402  0.000  11.8370 23.6450 31.8920 32.8470 34.0000 32.7250+402A
```

```
+402A    30.8720 23.7700 12.1230  0.000
$
AEFACT       452-23.5420-23.4510-22.7270-15.7150 -3.9300  7.6500 19.5500+452A
+452A    31.5200 40.9710 44.0950 44.6220
$
$ --- STA 560.  X AND Y
$
AEFACT       403  0.000  11.6020 23.1820 31.7430 32.8140 34.0000 32.7220+403A
+403A    30.8840 23.4290 11.8730  0.000
$
AEFACT       453-22.3500-22.2640-21.6050-15.2210 -3.6850  7.6500 19.2850+453A
+453A    30.9940 39.7590 42.2730 42.6870
$
$ --- STA 590.  X AND Y
$
AEFACT       404  0.000  11.1580 22.2990 31.2480 32.5510 34.0000 32.5310+404A
+404A    30.8290 22.7680 11.4470  0.000
$
AEFACT       454-20.1440-20.0660-19.5010-14.1590 -3.1080  7.6500 18.7370+454A
+454A    30.0230 37.4200 38.9570 39.1980
$
$ --- STA 620.  X AND Y
$
AEFACT       405  0.0000 10.5340 21.0600 30.4090 32.0550 34.0000 32.0660+405A
+405A    30.1390 21.3050 10.6720  0.0000
$
AEFACT       455-16.7060-16.6500-16.2560-12.4960 -2.1640  7.6500 17.6880+455A
+455A    28.1170 33.2710 34.1050 34.2390
$
$ --- STA 650.  X AND Y
$
AEFACT       406  0.0000  9.7280 19.4510 28.9330 31.3160 34.0000 31.3320+406A
+406A    28.5470 19.3140  9.6610  0.000
$
AEFACT       456-11.8410-11.8070-11.5520 -9.8970 -0.7540  7.6500 16.1610+456A
+456A    25.1430 27.4800 27.8240 27.8820
$
$ --- STA 672.732  X AND Y
$
AEFACT       407  0.0000  9.0460 18.0900 27.0680 30.3590 34.0000 30.5180+407A
+407A    26.4540 17.6550  8.8280  0.0000
$
AEFACT       457 -8.1550 -8.1240 -7.9620 -6.9860  0.7550  7.6500 14.6750+457A
+457A    21.4790 22.0810 22.1890 22.1670
$
$ATTACH-EID-----CAEROID-BOX1ST--BOXLAST-REFGID--
$ --- ATTACH AERO BOXES FOR FWD FUSELAGE TO SEVERAL GRIDS TO SPREAD OUT LOAD
$ATTACH   100      100      100      163      2157 $ OLD ATTACH FOR FWD FUSEL
$
ATTACH   100      100      100      107      2004
ATTACH   100      100      108      115      2006
ATTACH   100      100      116      123      2036
ATTACH   100      100      124      131      2066
ATTACH   100      100      132      139      2108
```

```
ATTACH   100      100      140      147      2157
ATTACH   100      100      148      155      2211
ATTACH   100      100      156      163      2226
$
$ --- MID FUSELAGE FORWARD ATTACHES TO ROOT END OF CANARD SPINDLE
$
ATTACH   200      200      200      263      3120
$
$ --- MID FUSELAGE AFT AND AFT FUSELAGE ATTACHES AT THE FWD ENGINE MOUNT
$
ATTACH   300      300      300      333      4058
ATTACH   400      400      400      459      4058
$
$-------------------------------------------------------------------
$
$ --- UNSTEADY AERO MODEL DATA
$
$ ---  WING UNSTEADY AERO
$ ---  - EXTENDS TO CENTERLINE BECAUSE NO BODIES IN SUPERSONIC UNSTEADY AERO
$ ---    SAME SPLINE SET AS STEADY AERO
$ ---      LOWER WING SURFACE GRIDS  3 SPLINES:
$ ---          INBOARD OF AILERON
$ ---          FORWARD OF AILERON
$ ---                     AILERON
$
$CAERO1 EID-----BID-----CP------NSPAN---NCHORD--LSPAN---LCHORD--IGID
CAERO1  20001                   10                      2002    1       +CA2001
+CA2001  370.975  0.      10.625  310.791 601.637 194.366  -6.38   55.94
$+CA2001  411.324 34.       7.65   266.21  601.637 194.366  -6.38   55.94
$+CA1---X1------Y1------Z1------X12-----X4------Y4------Z4------X43-----
$
$ --- DIVISION VALUES CHORD CUTS - CHOSEN TO MATCH POSITION OF AILERON AT 82%
$
AEFACT  2002     .0      .05     .10     .18     .28     .43     .58    +AE2002A
+AE2002A .71     .82     .91     1.0
$
$SPLINE1 EID----CP------CAERO---BOX1----BOX2----SETG----DZ------
SPLINE1  2001             20001   20001   20040   201
SPLINE1  2002             20001   20041   20098   202
SPLINE1  2003             20001   20049   20100   203
$
$SET1---SID-----G1------G2------G3------G4------G5------G6------G7------
SET1     201     1001    1003    1005    1007    1009    1011    1013
SET1     201     1015    1017
SET1     201     1021    1023    1025    1027    1029    1031    1033
SET1     201     1035    1037
SET1     201     1041    1043    1045    1047    1049    1051    1053
SET1     201     1061    1065    1067    1069    1071    1073    1075
$
SET1     202     1061    1065    1067    1069    1071    1073    1075
SET1     202     1081    1087    1089    1091    1093    1095
SET1     202     1101    1109    1111    1113    1115
SET1     202     1121    1131    1133    1135
SET1     202     1141    1151    1153    1155
```

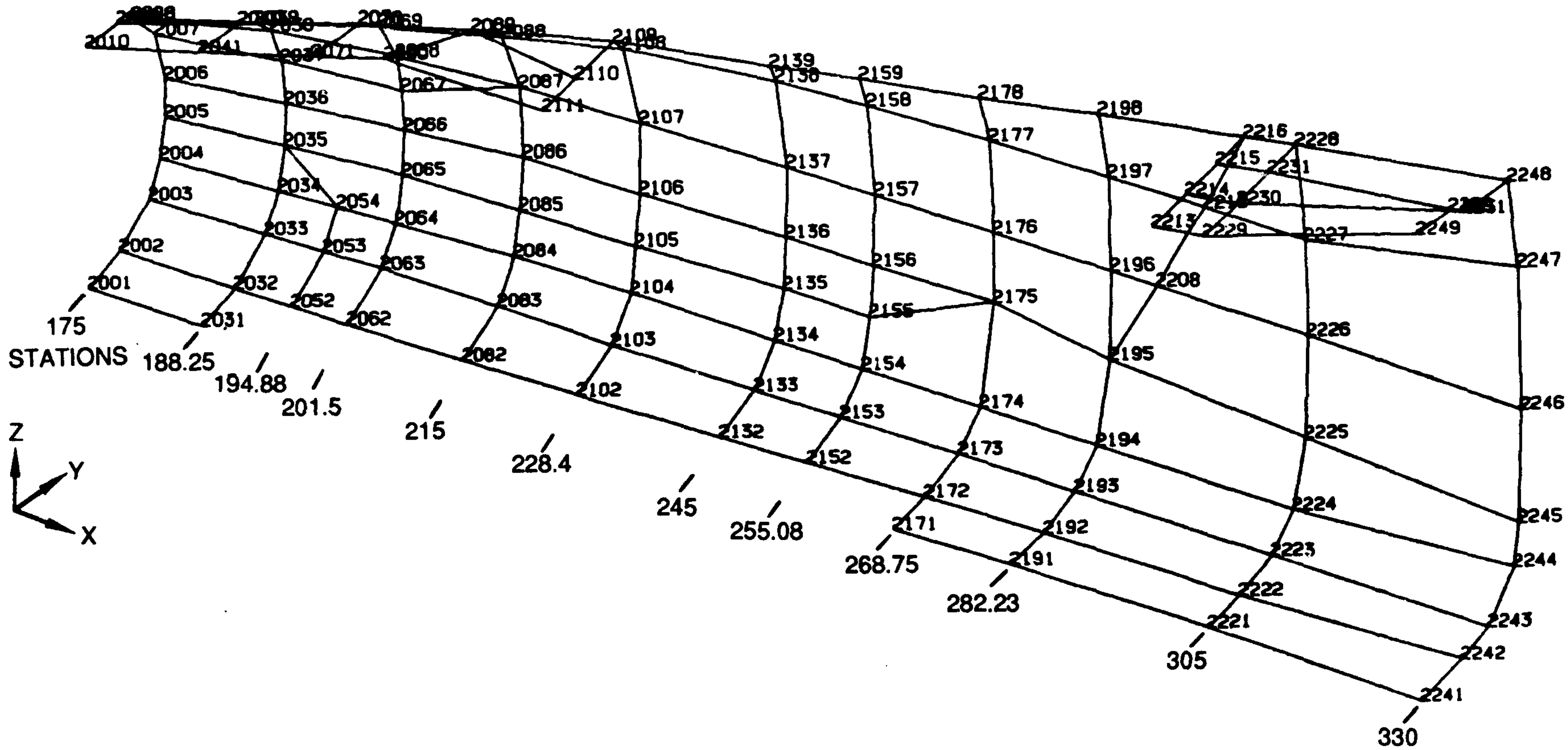
```
$
SET1     203      1077     1079
SET1     203      1097     1099
SET1     203      1117     1119
SET1     203      1137     1139
SET1     203      1157     1159
$
$ - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
$ ---  CANARD UNSTEADY AERO
$ ---     MOVED FWD 24. INCHES TO MATCH STEADY AERO
$ ---   - EXTENDS TO CENTERLINE BECAUSE NO BODIES IN SUPERSONIC UNSTEADY AERO
$ ---     ATTACHED TO CANARD SPINDLE TIP GRID
$
$CAERO1 EID-----BID-----CP------NSPAN---NCHORD--LSPAN---LCHORD--IGID
CAERO1  22001                   8       7                       1       +CA2201
+CA2201  225.466   0.     19.515 180.708 402.248 102.062 26.620   27.982
$+CA2201  249.466   0.     19.515 180.708 426.248 102.062 26.620   27.982
$+CA1---X1------Y1------Z1------X12-----X4------Y4------Z4------X43-----
$
$ATTACH-EID-----CAEROID-BOX1ST--BOXLAST-REFGID--
ATTACH   22001    22001    22001    22056    3133
$
$ - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
$ ---  VERTICAL FIN UNSTEADY AERO
$ ---    56 AERO BOXES
$ ---    SPLINED TO 4 CORNER GRIDS ONLY
$
$CAERO1 EID-----BID-----CP------NSPAN---NCHORD--LSPAN---LCHORD--IGID
CAERO1  24001                   8       7                       1       +CA2401
+CA2401  665.     70.      19.      102.     761.93  47.96    101.78  32.29
$+CA1---X1------Y1------Z1------X12-----X4------Y4------Z4------X43-----
$
$SPLINE1 EID----CP------CAERO---BOX1----BOX2----SETG----DZ------
SPLINE1  2401              24001    24001    24056    241
$
$SET1---SID-----G1------G2------G3------G4------G5------G6------G7------
SET1     241      5129     5133     5149     5153
$
$ - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
$ --- FLUTTER DATA
$ ---  REF CHORD = MEAN AERODYNAMIC CHORD OF WING
$ ---  REF DENSITY IS AT SEA LEVEL IN CONSISTENT MASS UNITS LBM-SEC**2/IN**4
$AERO---CP------CHORD---RHOREF--
AERO              212.9    .1147-6
$
$MKAERO1 SYMXZ--SYMXY---M1------M2------M3------M4------M5------M6-----
MKAERO1 1                1.5                                            +MK1
+MK1     .2       0.40     .8       1.60     3.00     6.
$+MKA1--K1------K2------K3------K4------K5------K6------K7------
$
$FLUTTR SID-----METH----DENS----MACH----VEL-----MODE-DEL KLIST--EFF SET-+CONT
$FLUTTER 100      PK       120      1.5      140                        +FL100
FLUTTER 100      PK       120      1.5      140      150                +FL100
+FL100   1
```

```
$
FLUTTER 101     PK      120     1.5     140     151                             +FL101
+FL101   1
$
FLUTTER 102     PK      120     1.5     142     151                             +FL102
+FL102   1
$
FLUTTER 103     PK      120     1.5     143     151                             +FL103
+FL103   1
$
$FLUTTER 444     PK      120     1.5     140     150                             +FL444
FLUTTER 444     PK      120     1.5     140                                     +FL444
+FL444  -1
$
$FLTFACT SID----F1------F2------F3------F4------F5------F6------F7------
FLFACT  120      .629
FLFACT  130     1.5
FLFACT  140     12000.  14000.  15000.  16000.  17000.  18000.  19027.  +FL140
+FL140  20000.  21000.  22000.  23000.
FLFACT  142     18000.  19027.
FLFACT  143     15000.  18000.  19027.
$
SET1    150     1       2       3
SET1    151     1       2       3       9       10
$
$
$DCONFLT SID----GFACT---V1------GAM1----V2------GAM2----V3------GAM3----
$DCONFLT  100     0.40    0.0     0.0     19027.  0.0     20000.  1.0     +FLT100
DCONFLT 100             0.0     0.0     19027.  0.0     20000.  1.0     +FLT100
+FLT100 20001.  10.     30000.  10.
$
ENDDATA
```

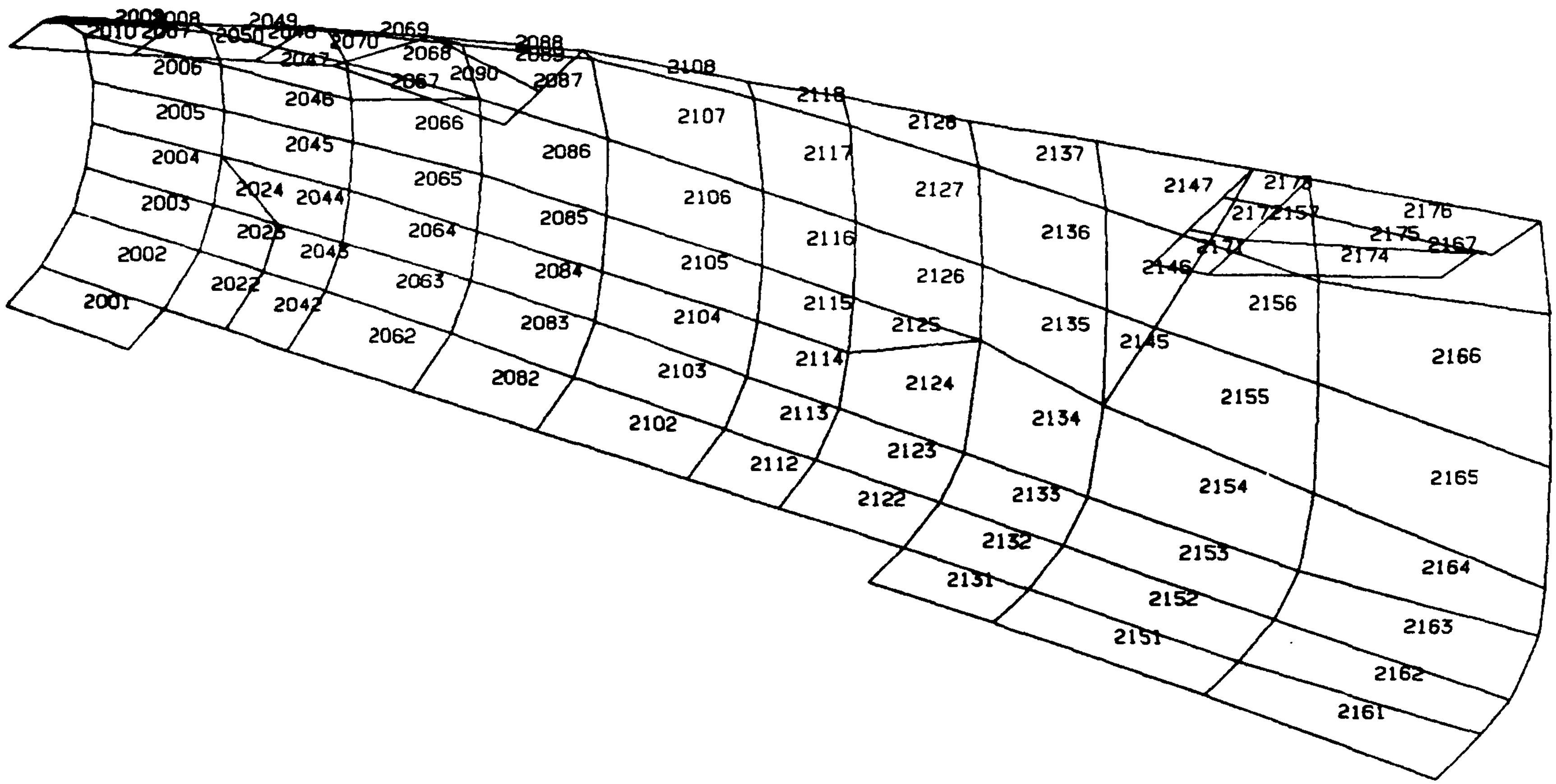
A P P E N D I X D

COMPLETE SET OF ELEMENT AND GRID NUMBER FIGURES

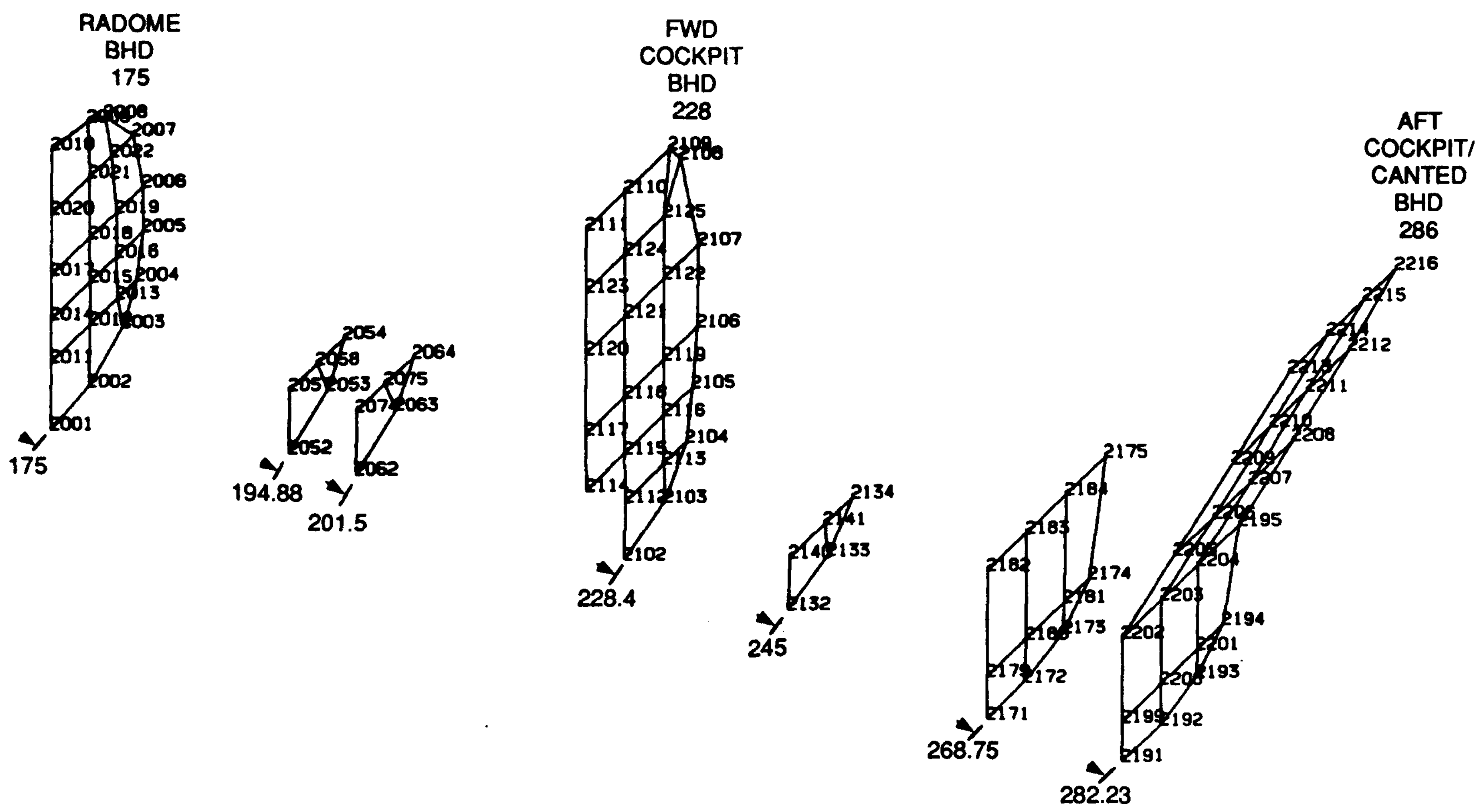
FORWARD FUSELAGE OML SKIN AND TOP DECK GRIDS



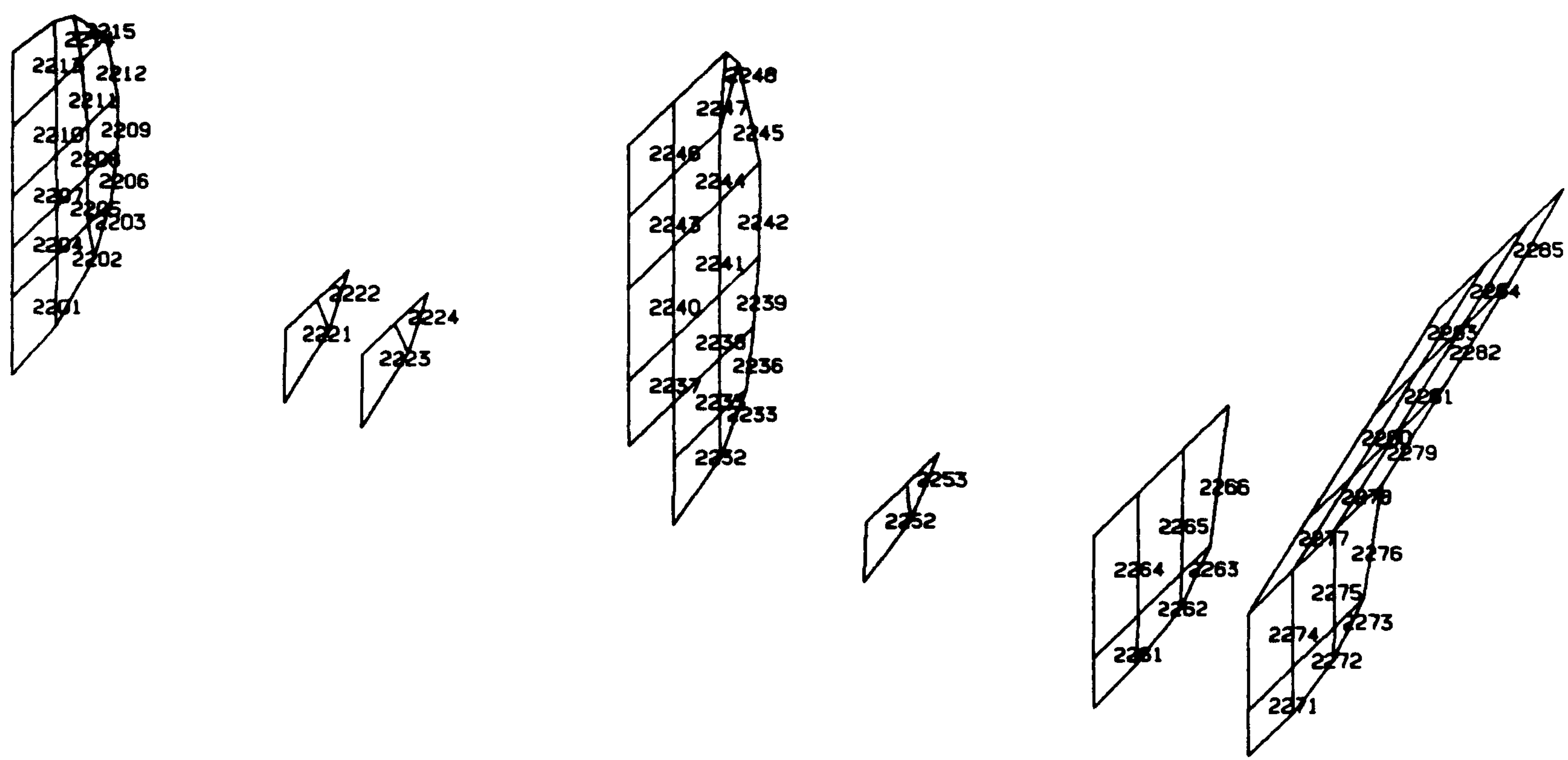
FORWARD FUSELAGE OML SKIN AND TOP DECK ELEMENTS



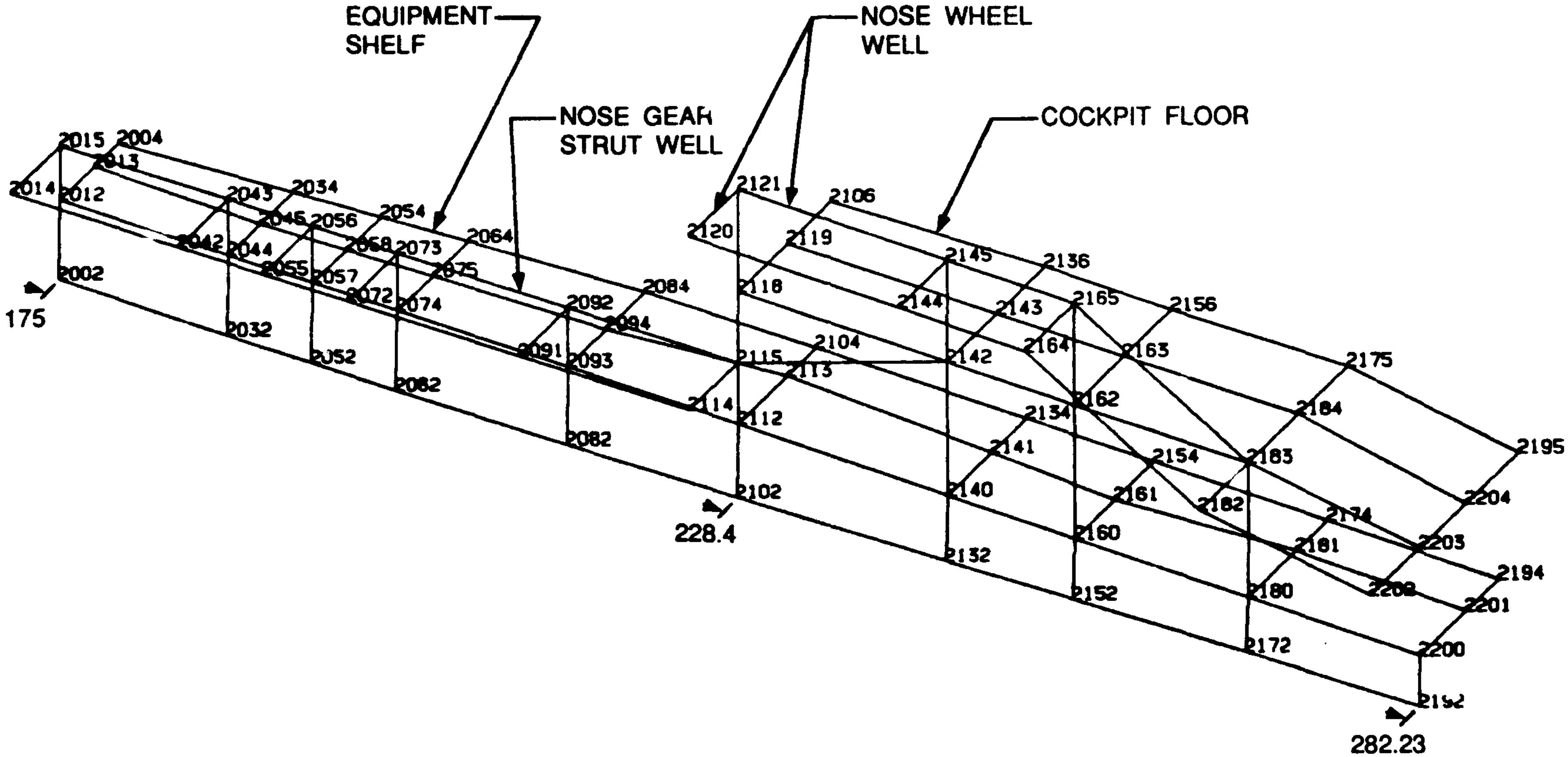
FORWARD FUSELAGE BULKHEAD AND FRAME GRIDS



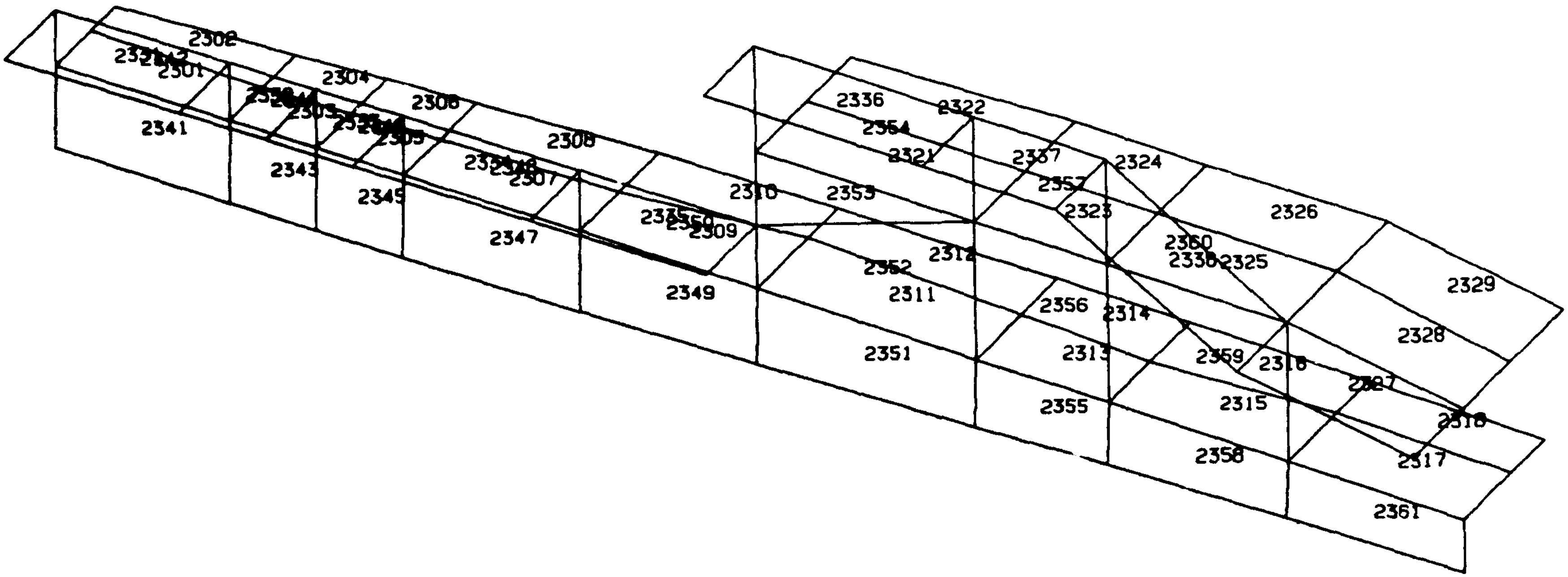
FORWARD FUSELAGE BULKHEAD AND FRAME ELEMENTS

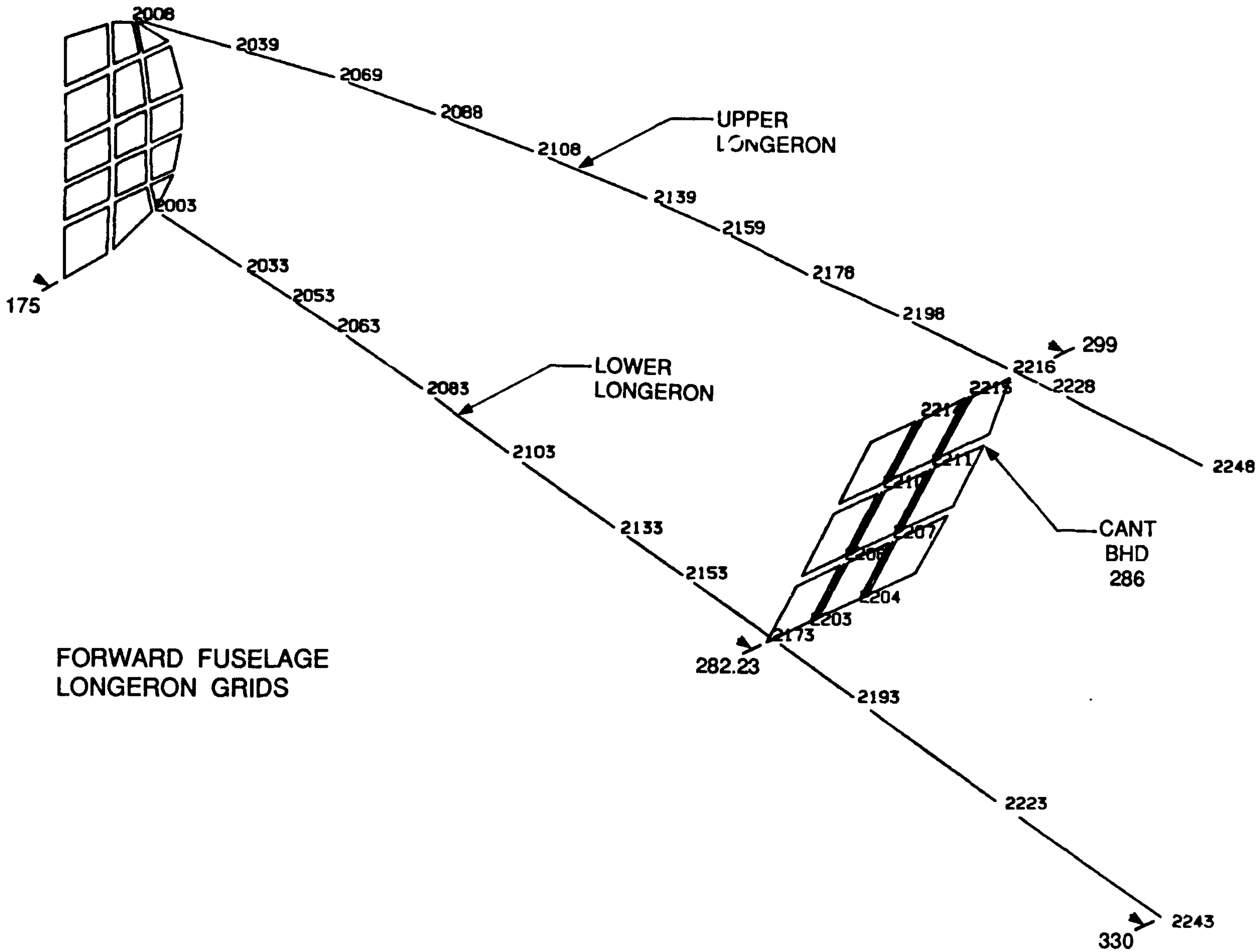


FORWARD FUSELAGE FLOORS AND WHEEL WELL GRIDS

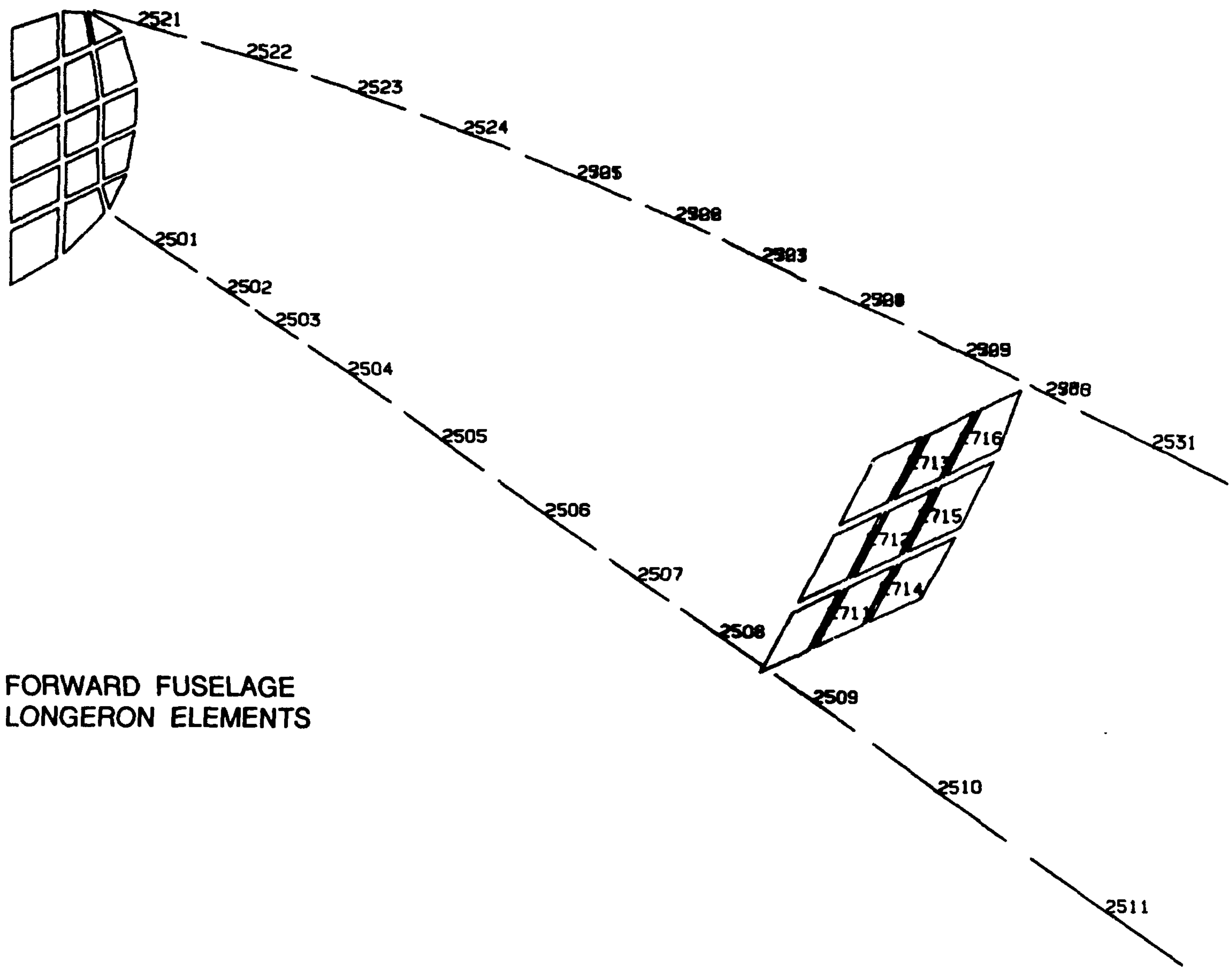


FORWARD FUSELAGE FLOORS AND WHEEL WELL ELEMENTS



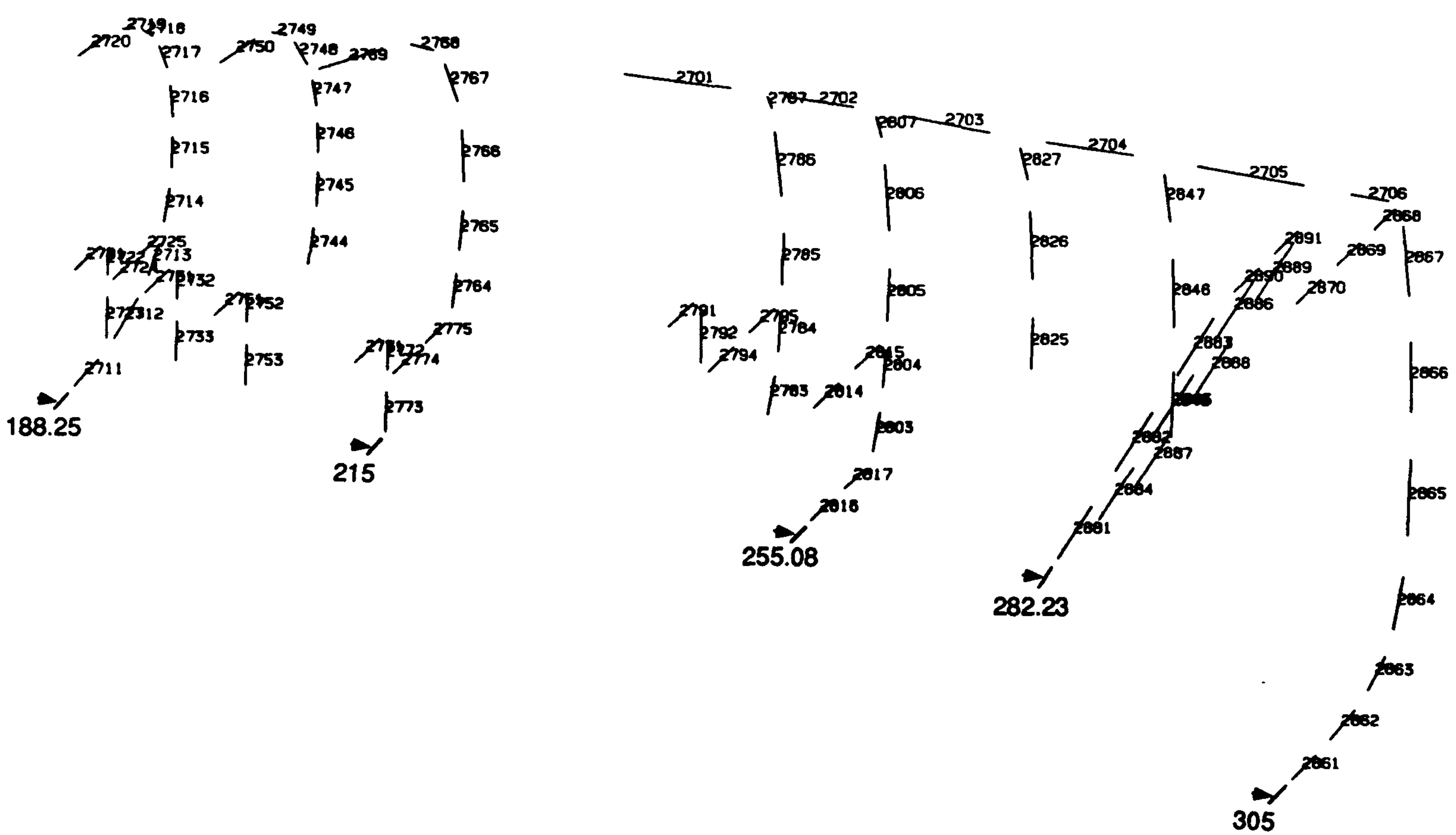


FORWARD FUSELAGE
LONGERON GRIDS

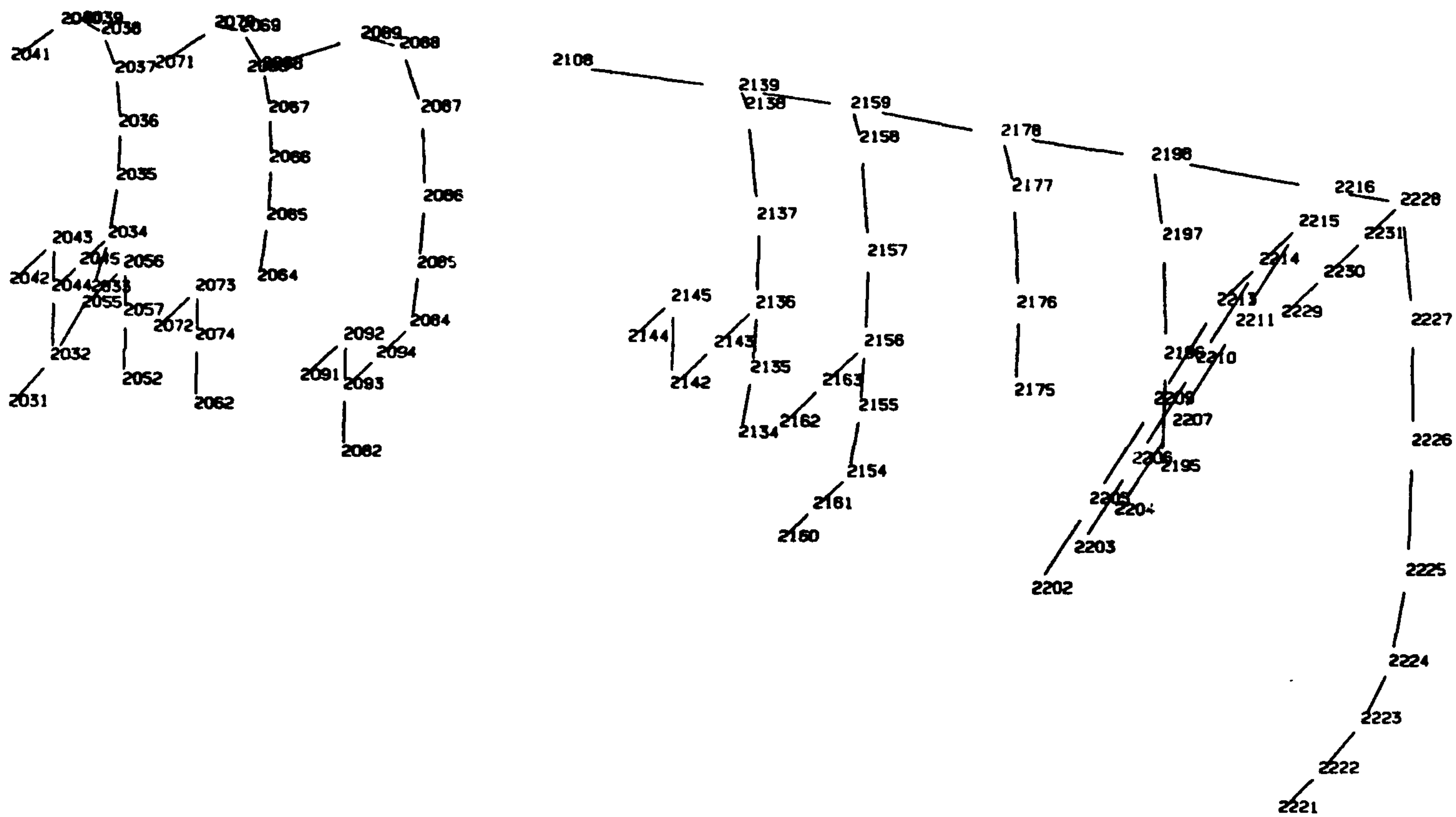


FORWARD FUSELAGE
LONGERON ELEMENTS

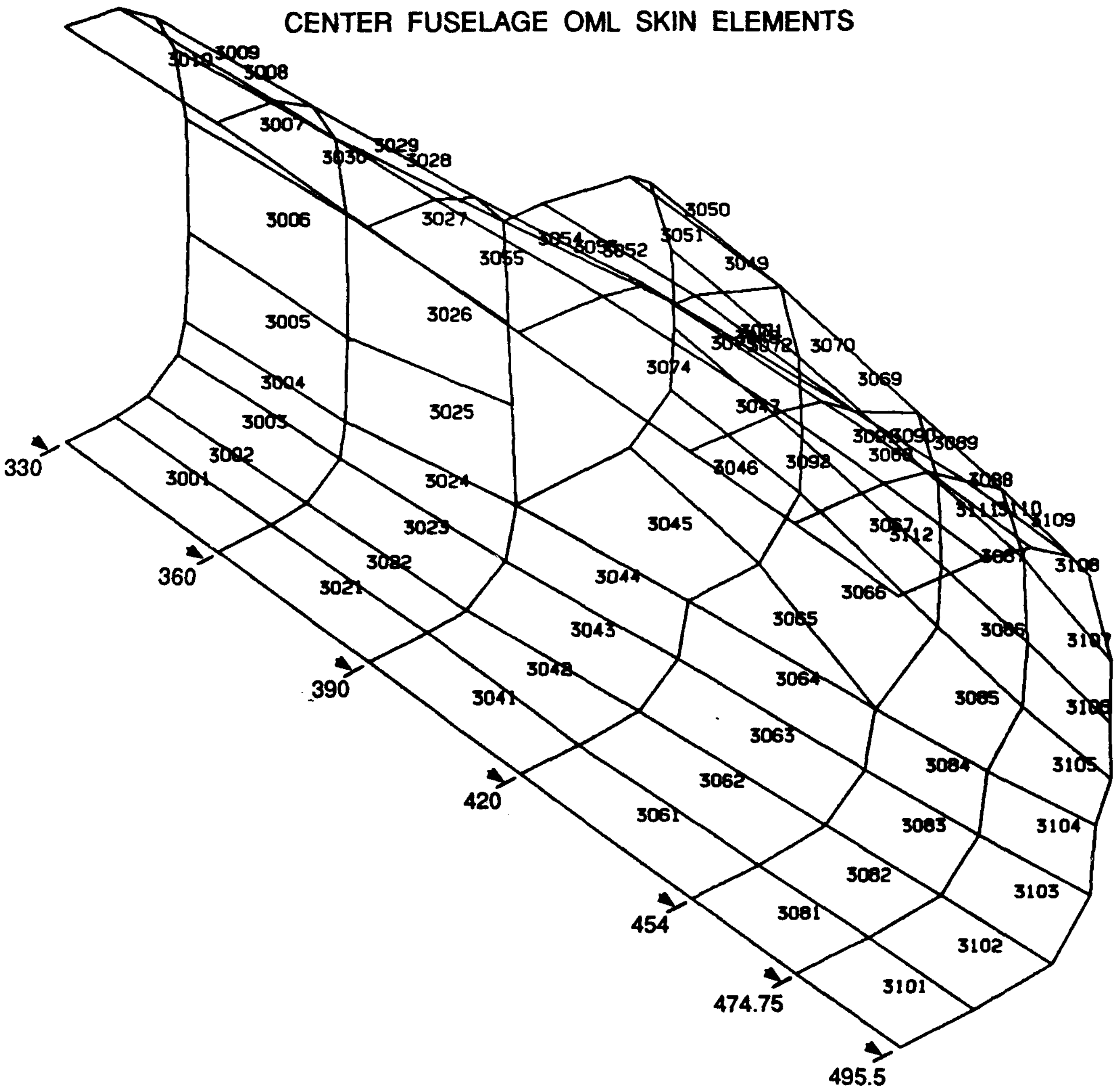
FORWARD FUSELAGE NUMERICAL STABILITY BAR GRIDS



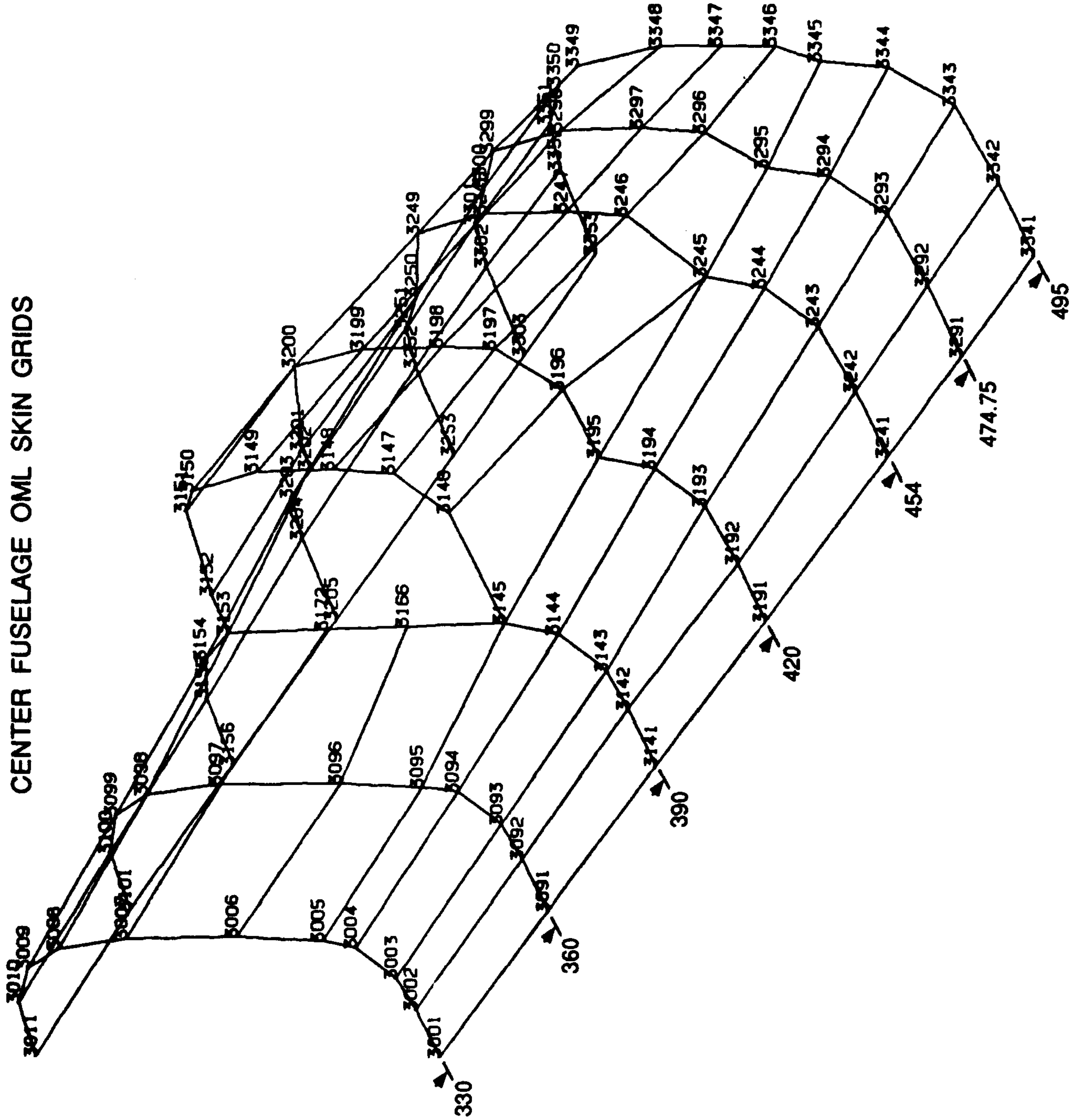
FORWARD FUSELAGE NUMERICAL STABILITY ELEMENTS



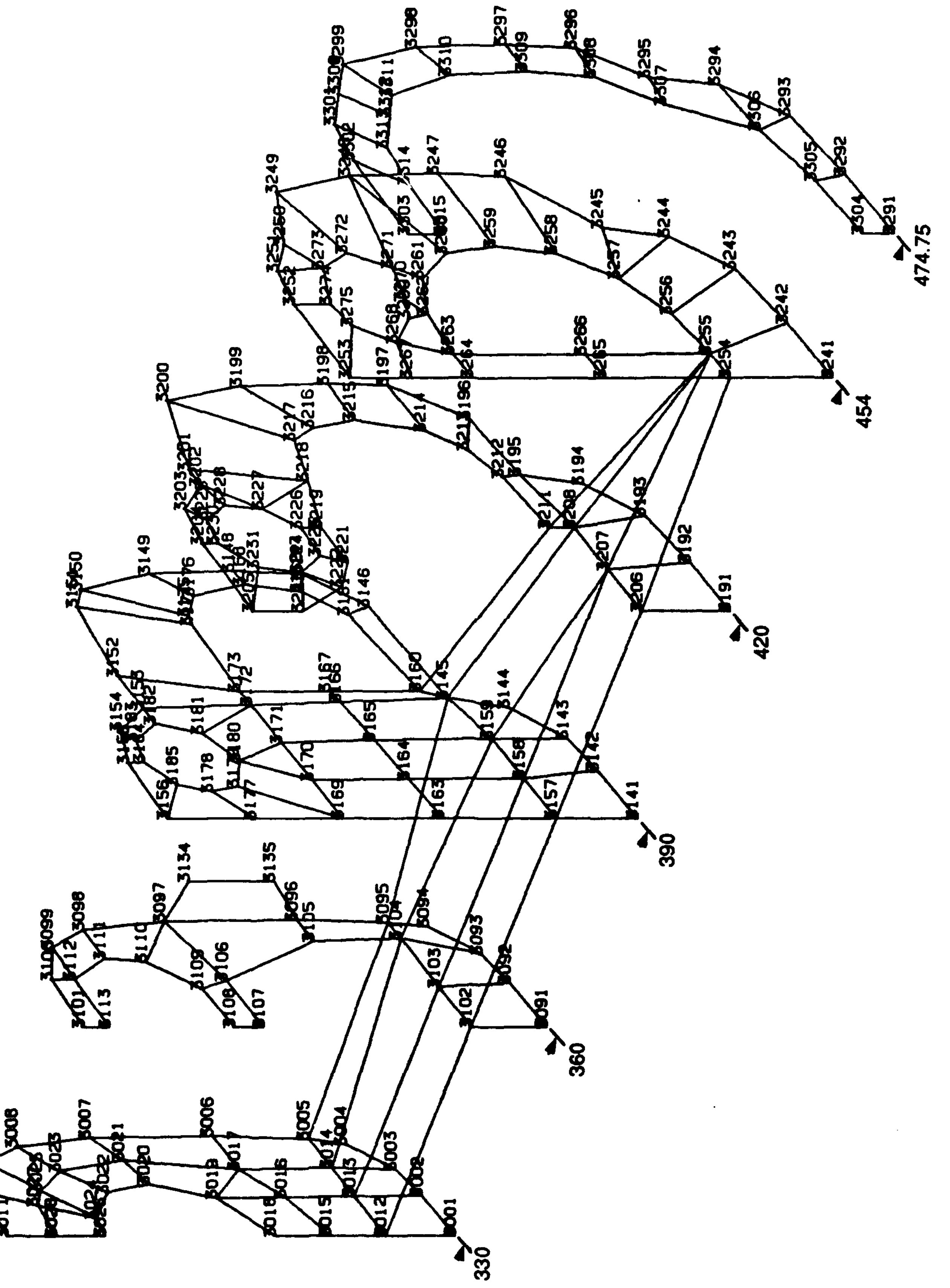
CENTER FUSELAGE OML SKIN ELEMENTS



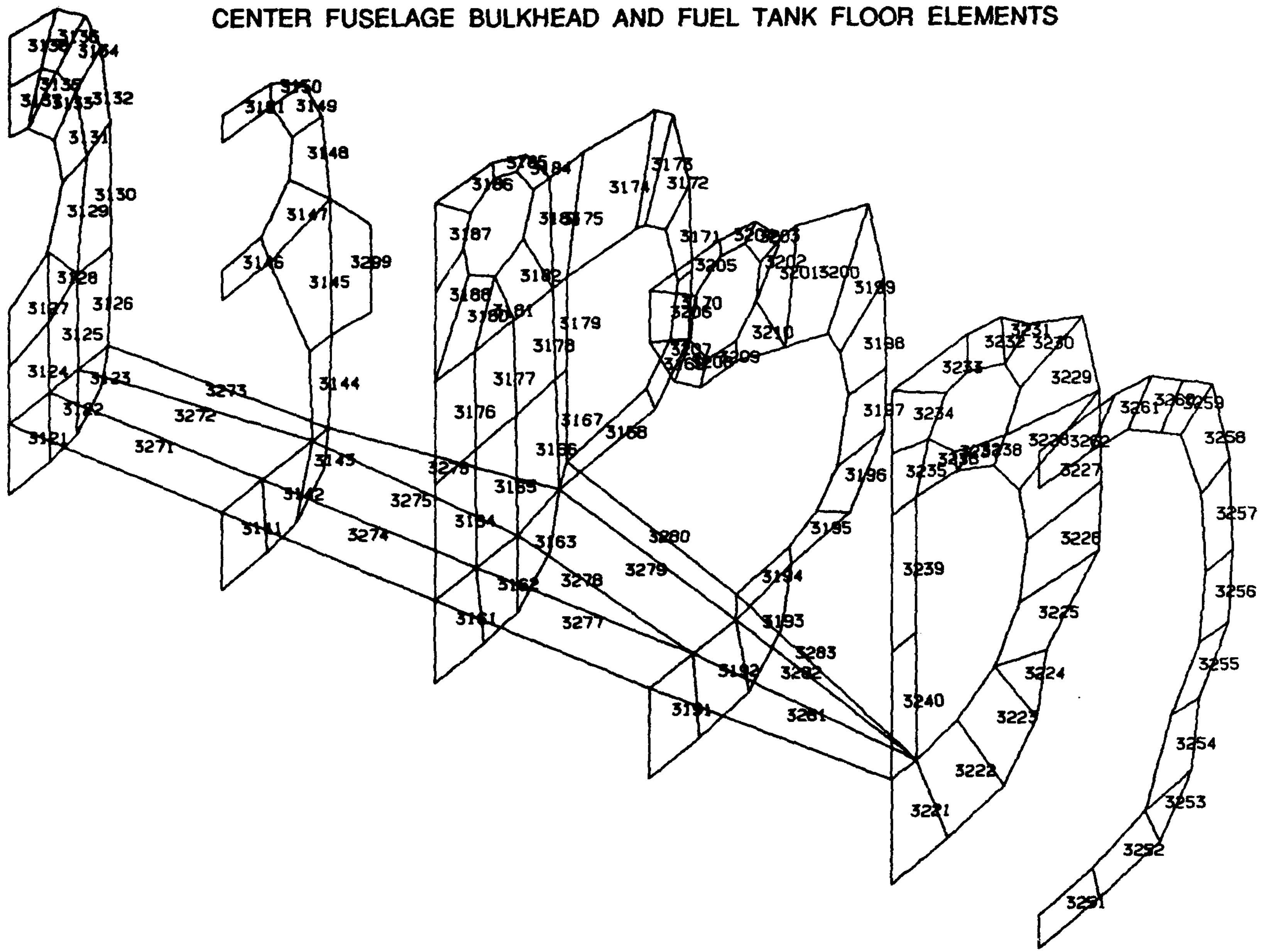
CENTER FUSELAGE OML SKIN GRIDS



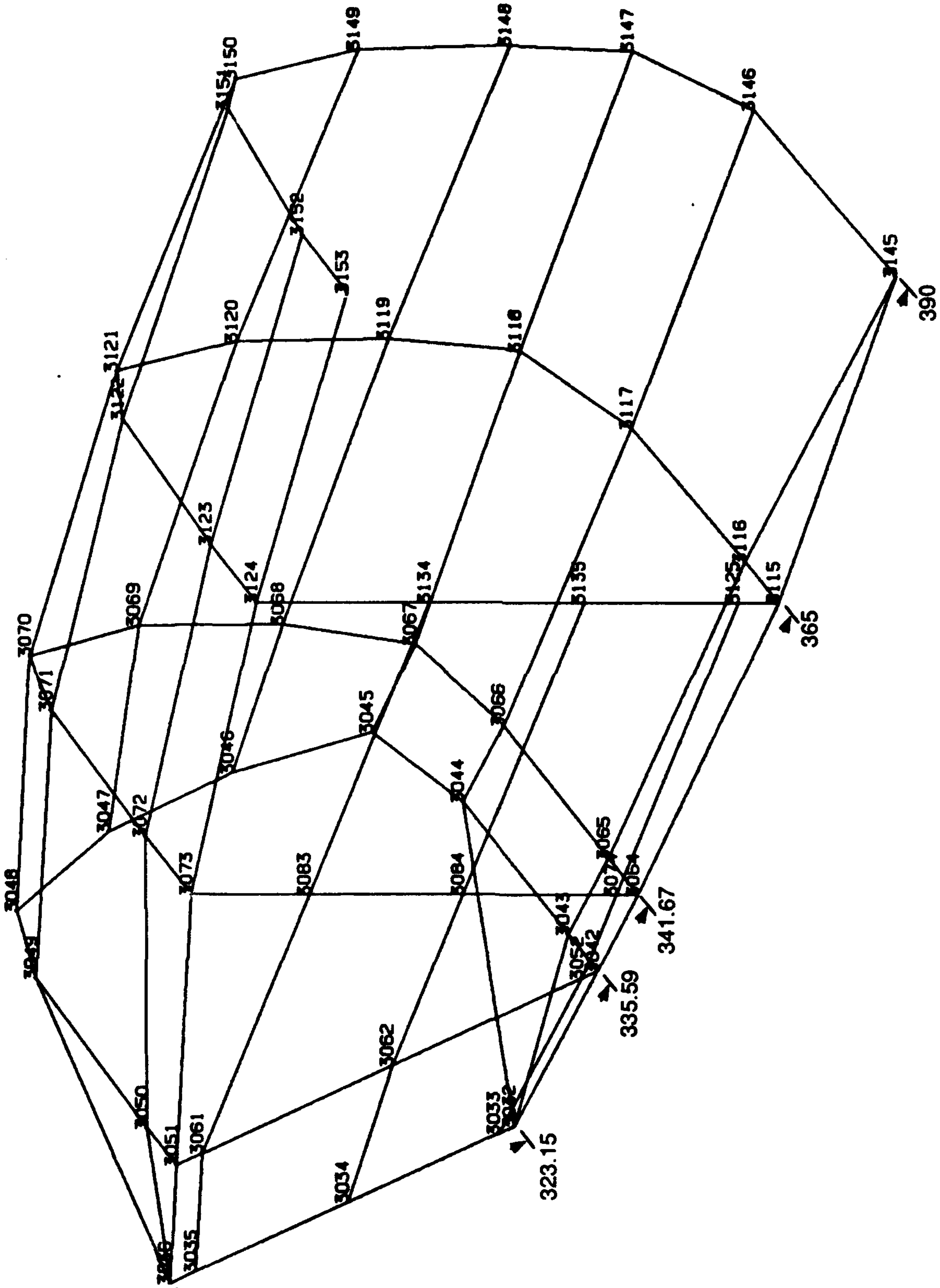
CENTER FUSELAGE BULKHEAD AND FUEL TANK FLOOR GRIDS



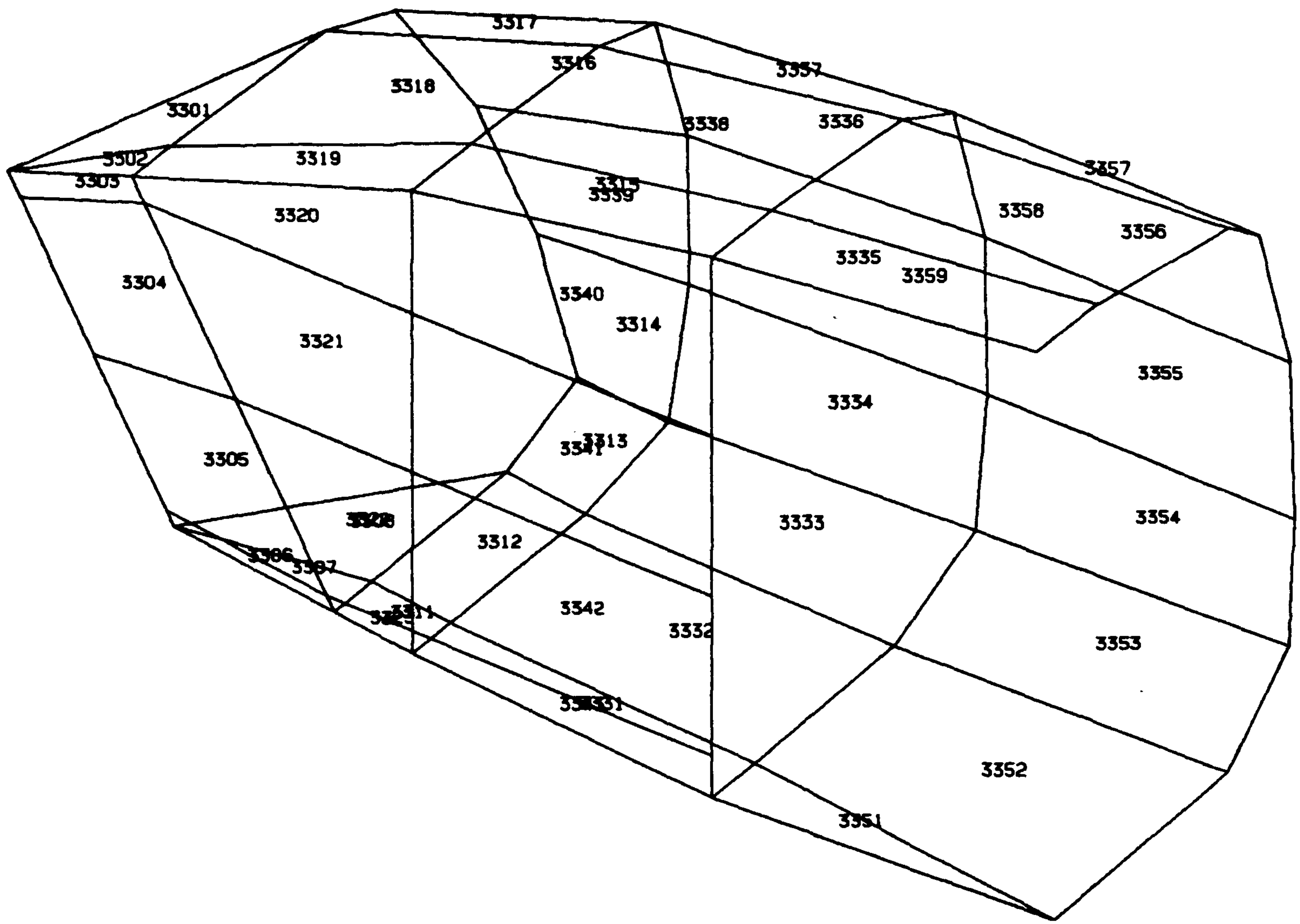
CENTER FUSELAGE BULKHEAD AND FUEL TANK FLOOR ELEMENTS



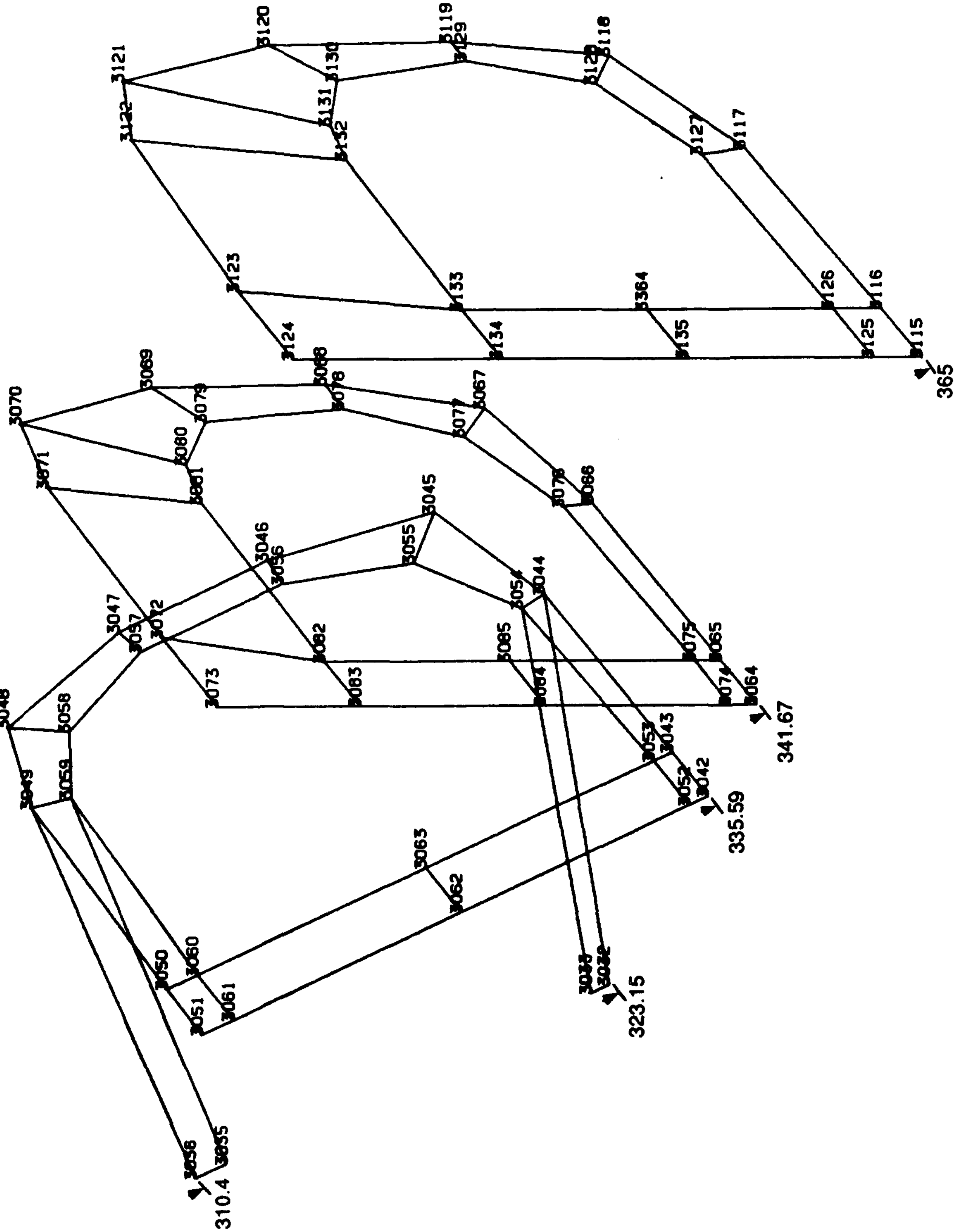
ENGINE INLET OML SKIN



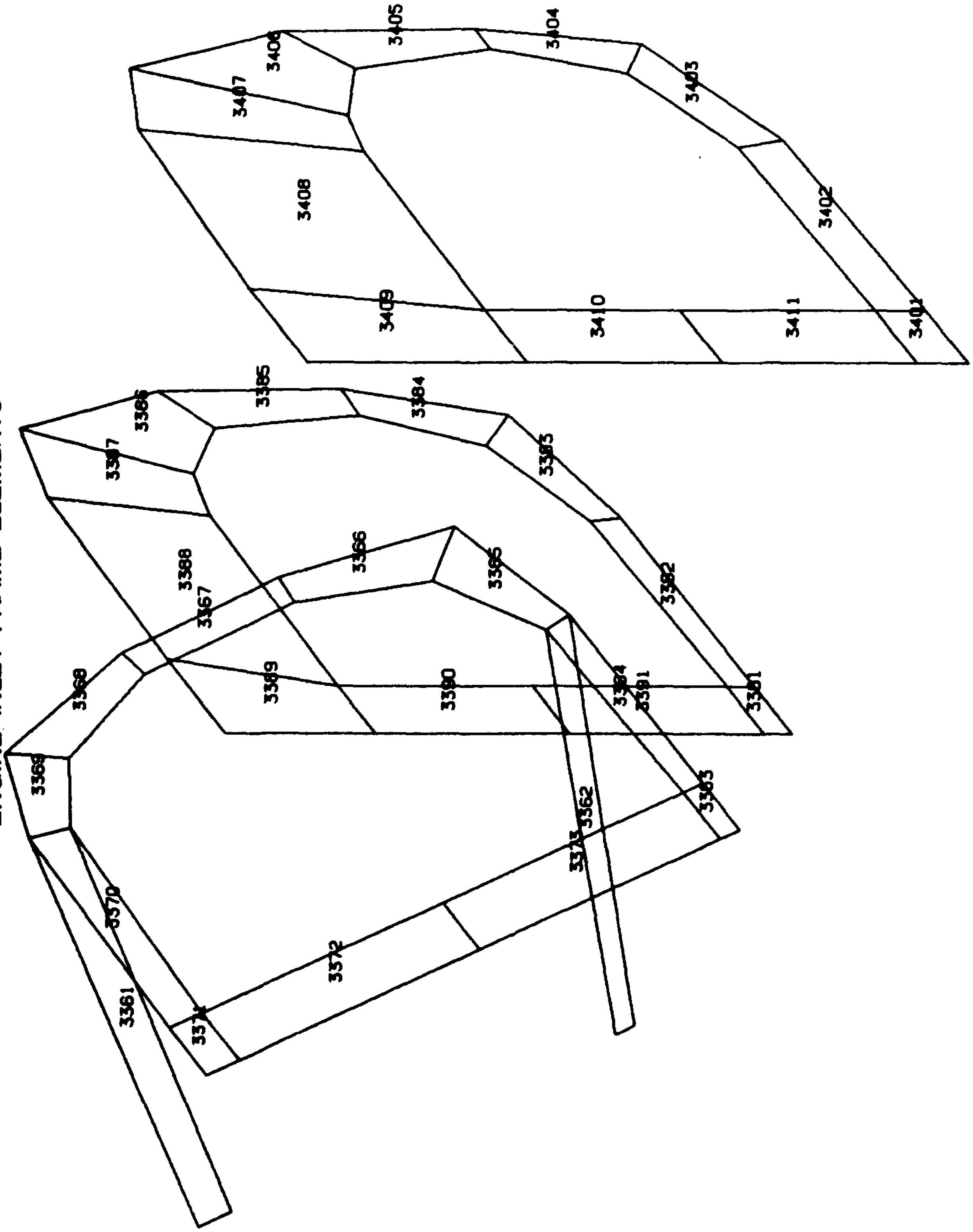
ENGINE INLET OML SKIN ELEMENTS



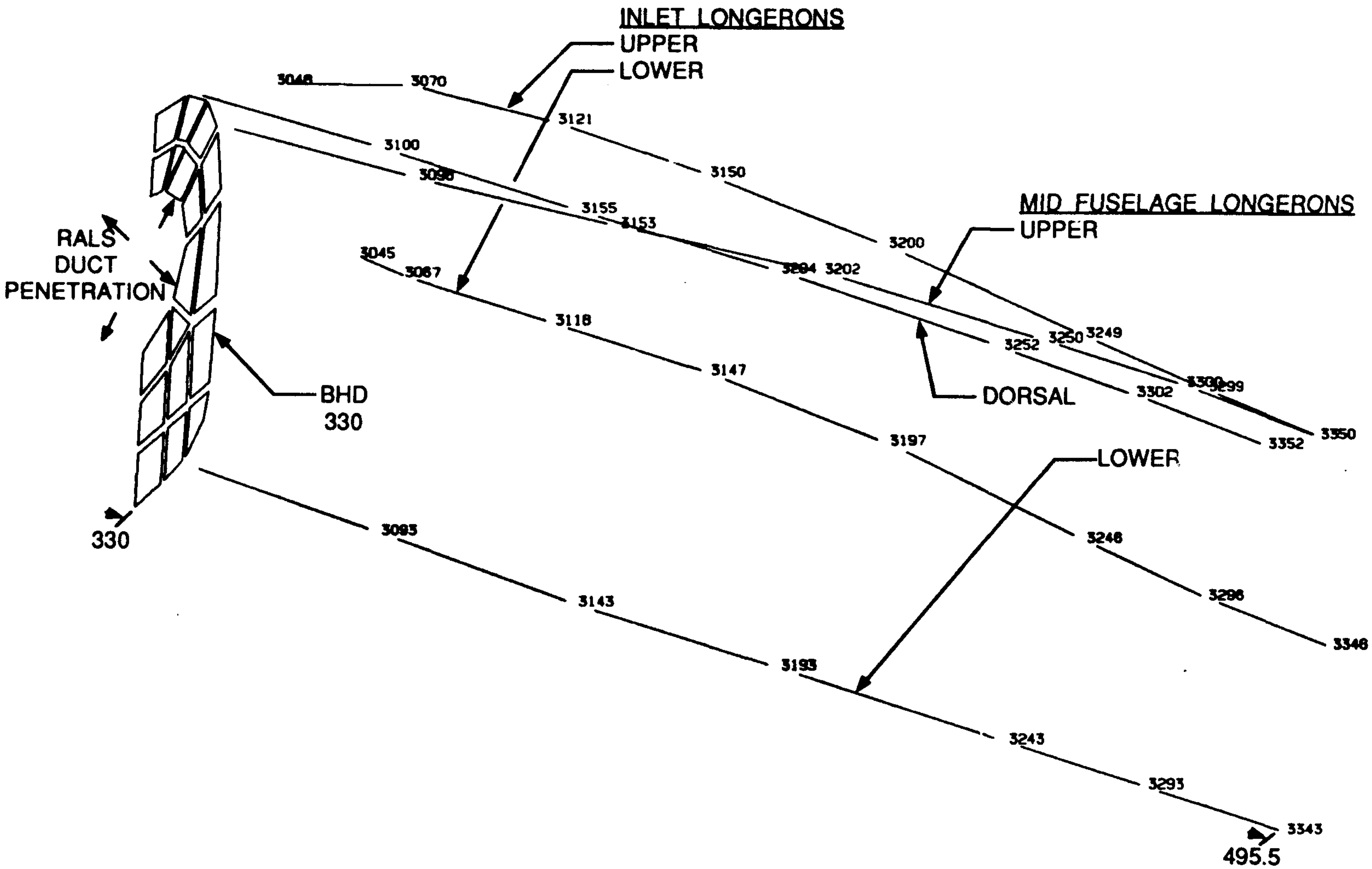
ENGINE INLET FRAME GRIDS



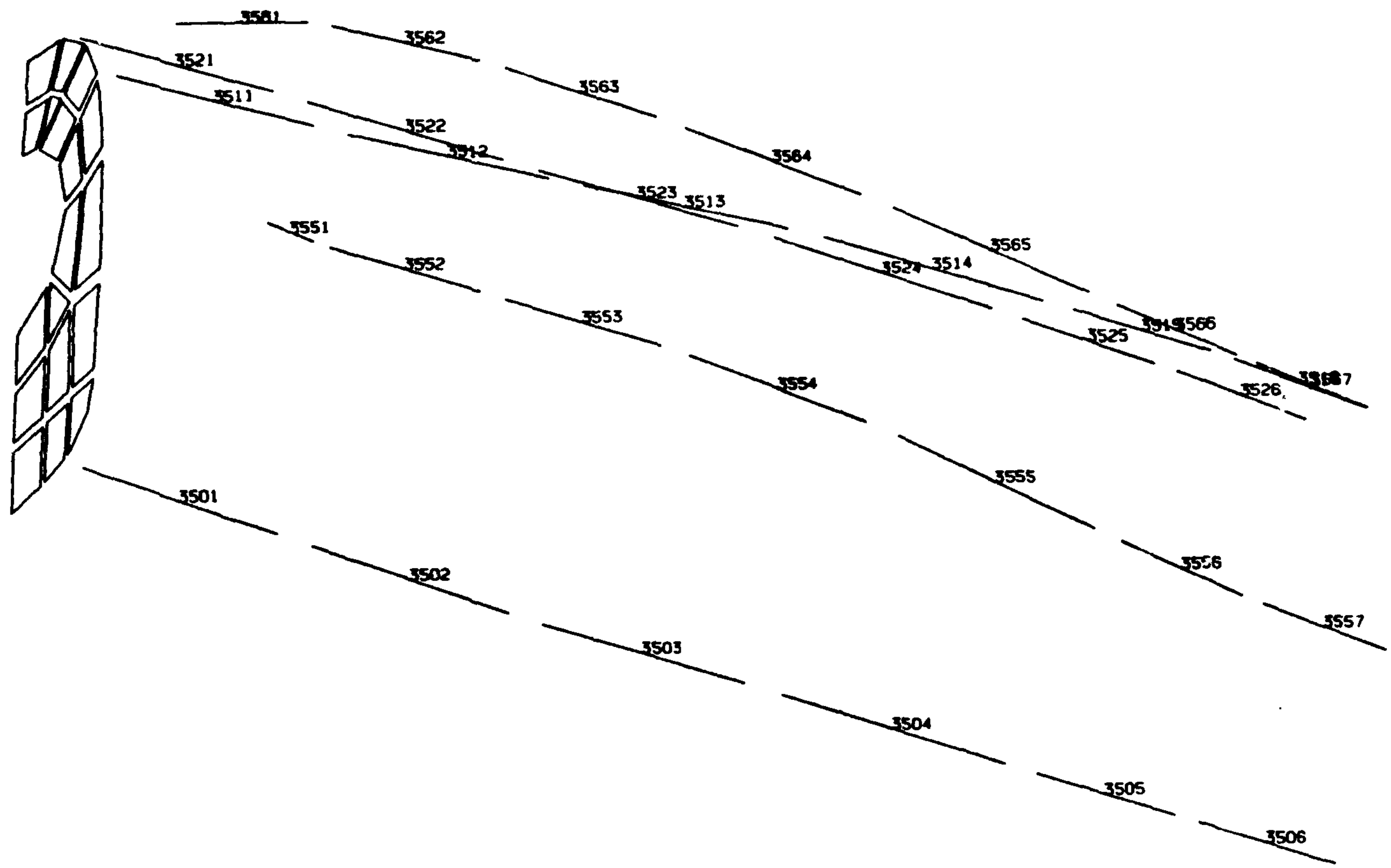
ENGINE INLET FRAME ELEMENTS



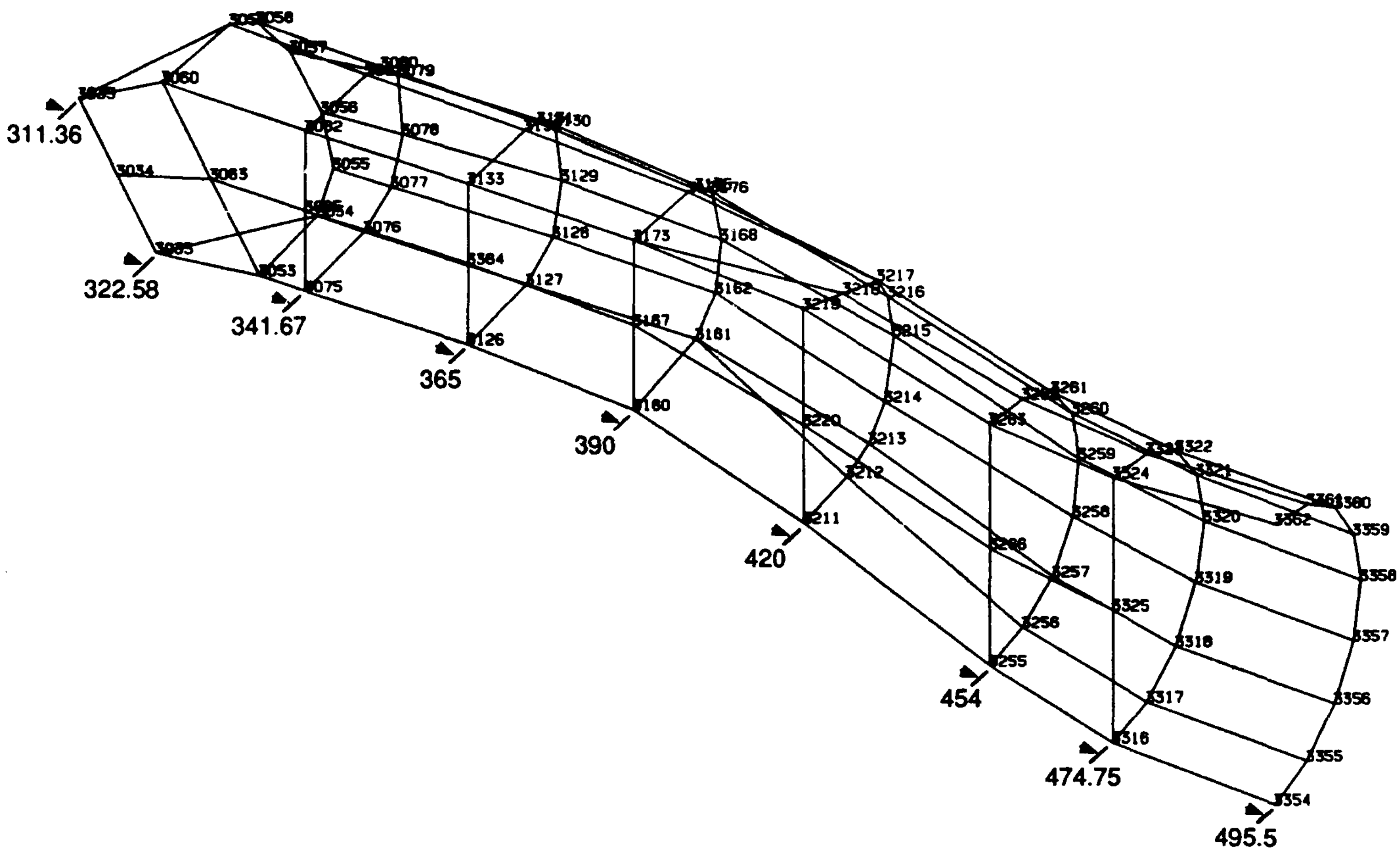
CENTER FUSELAGE LONGERON GRIDS



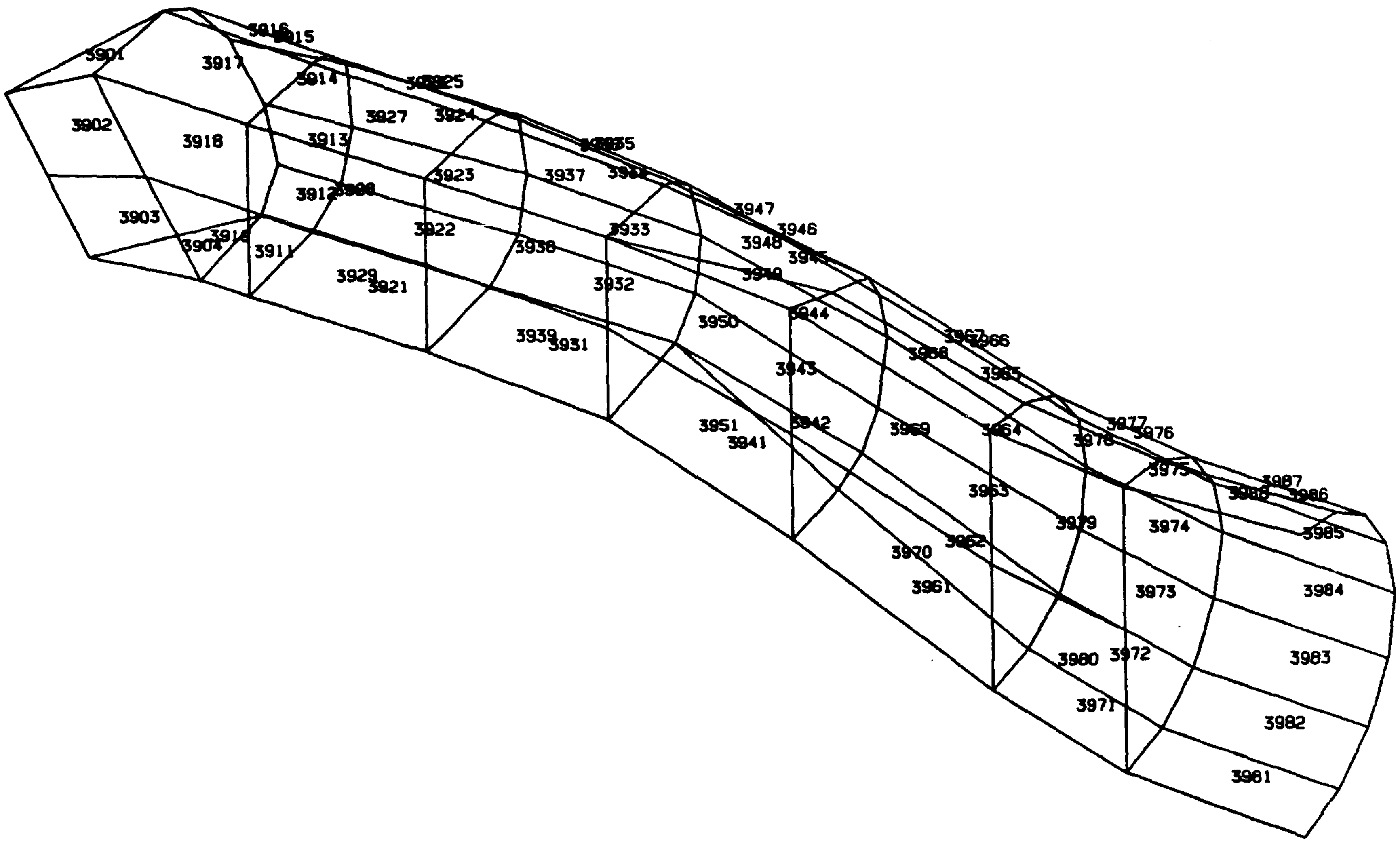
CENTER FUSELAGE LONGERON GRIDS



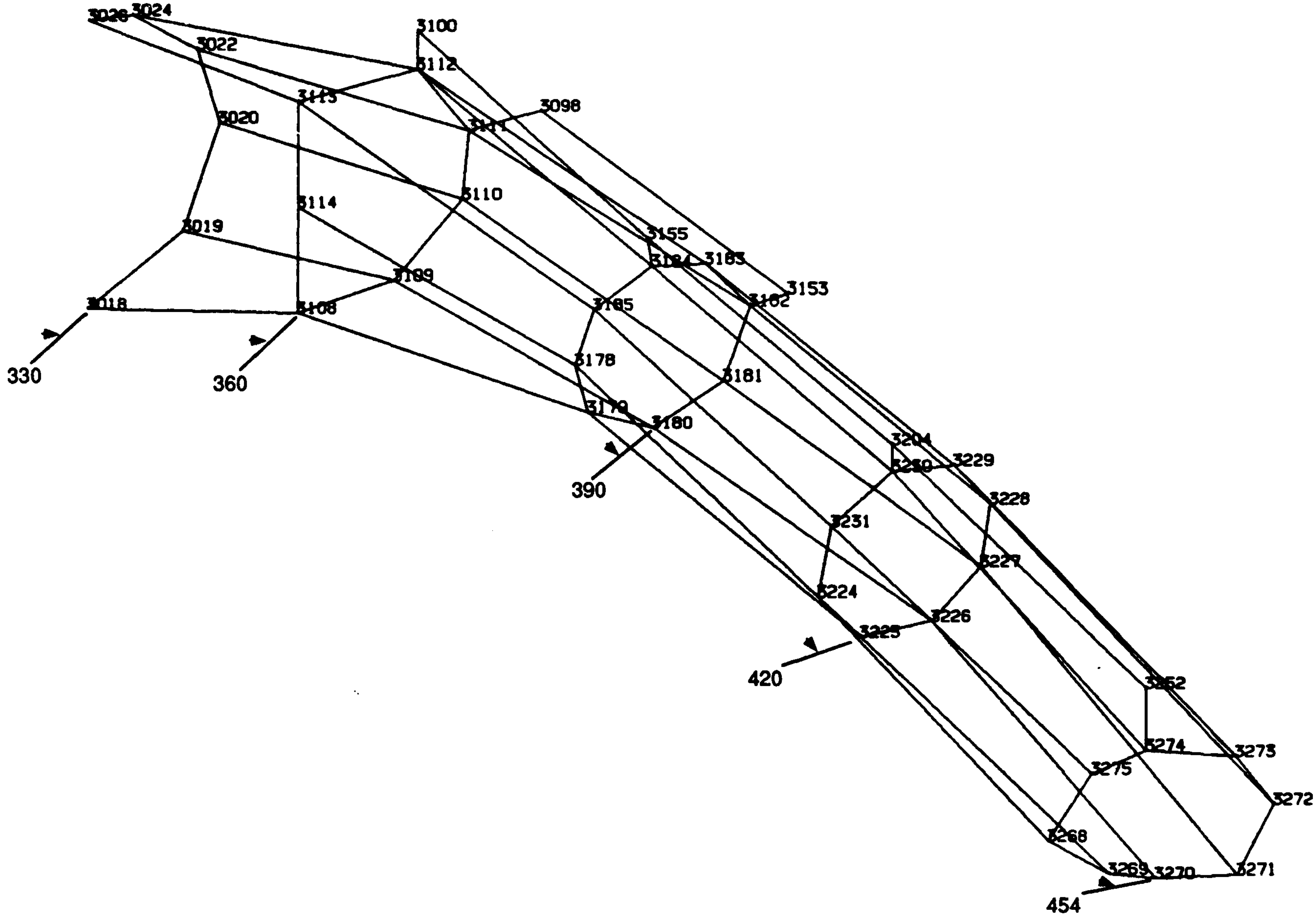
ENGINE INLET DUCT IML SKIN GRIDS



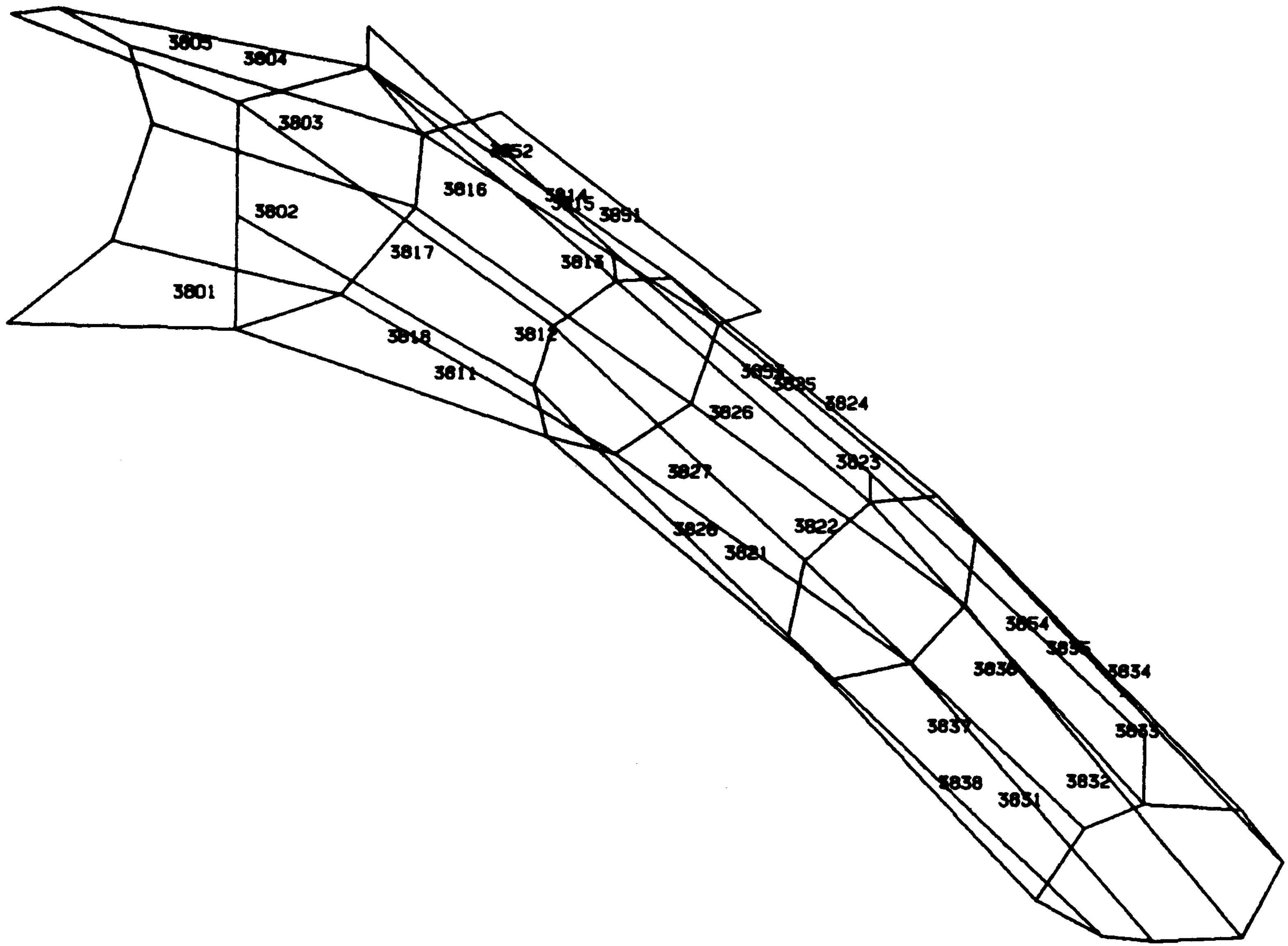
ENGINE INLET DUCT IML SKIN ELEMENTS



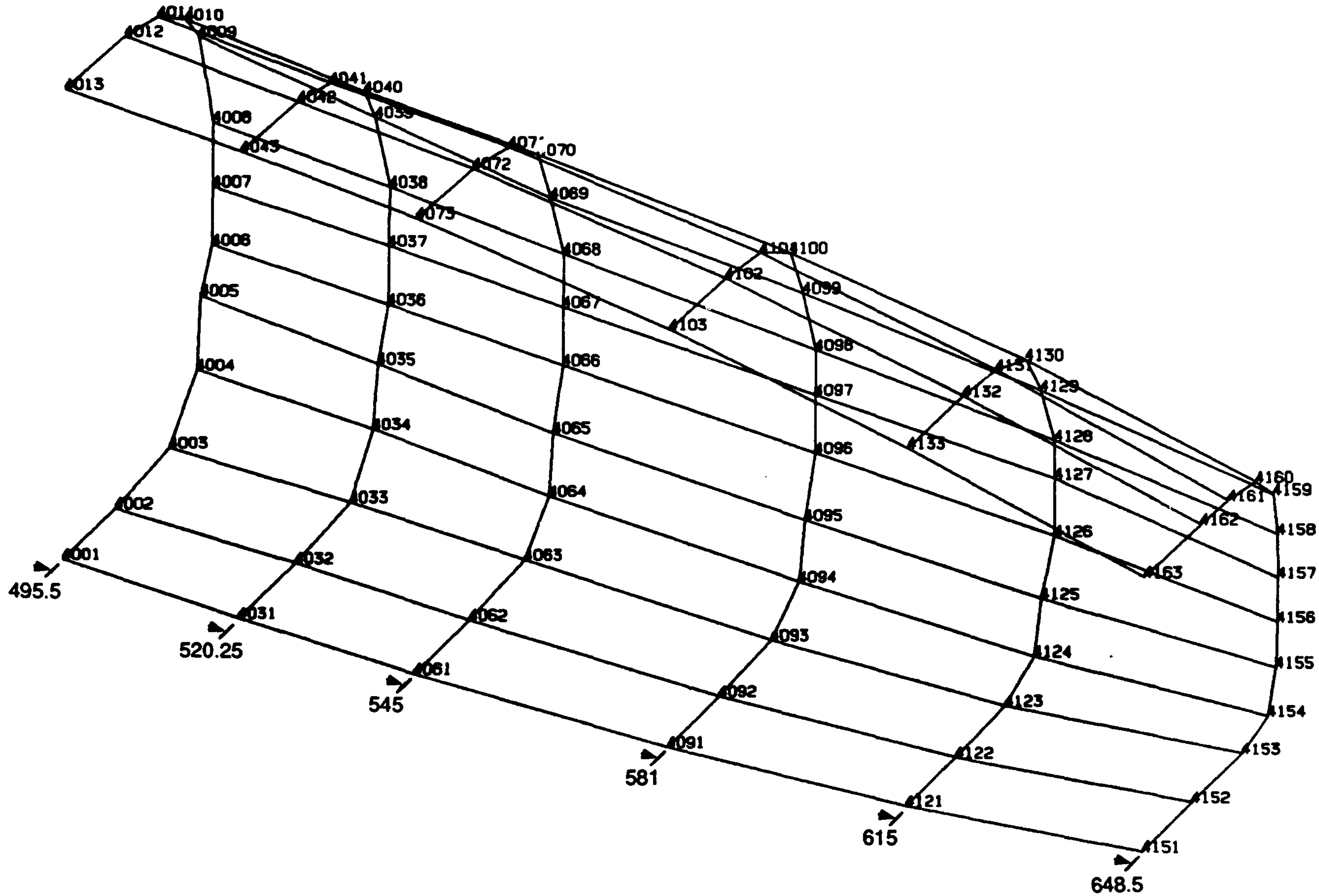
RALS DUCT TUNNEL GRIDS



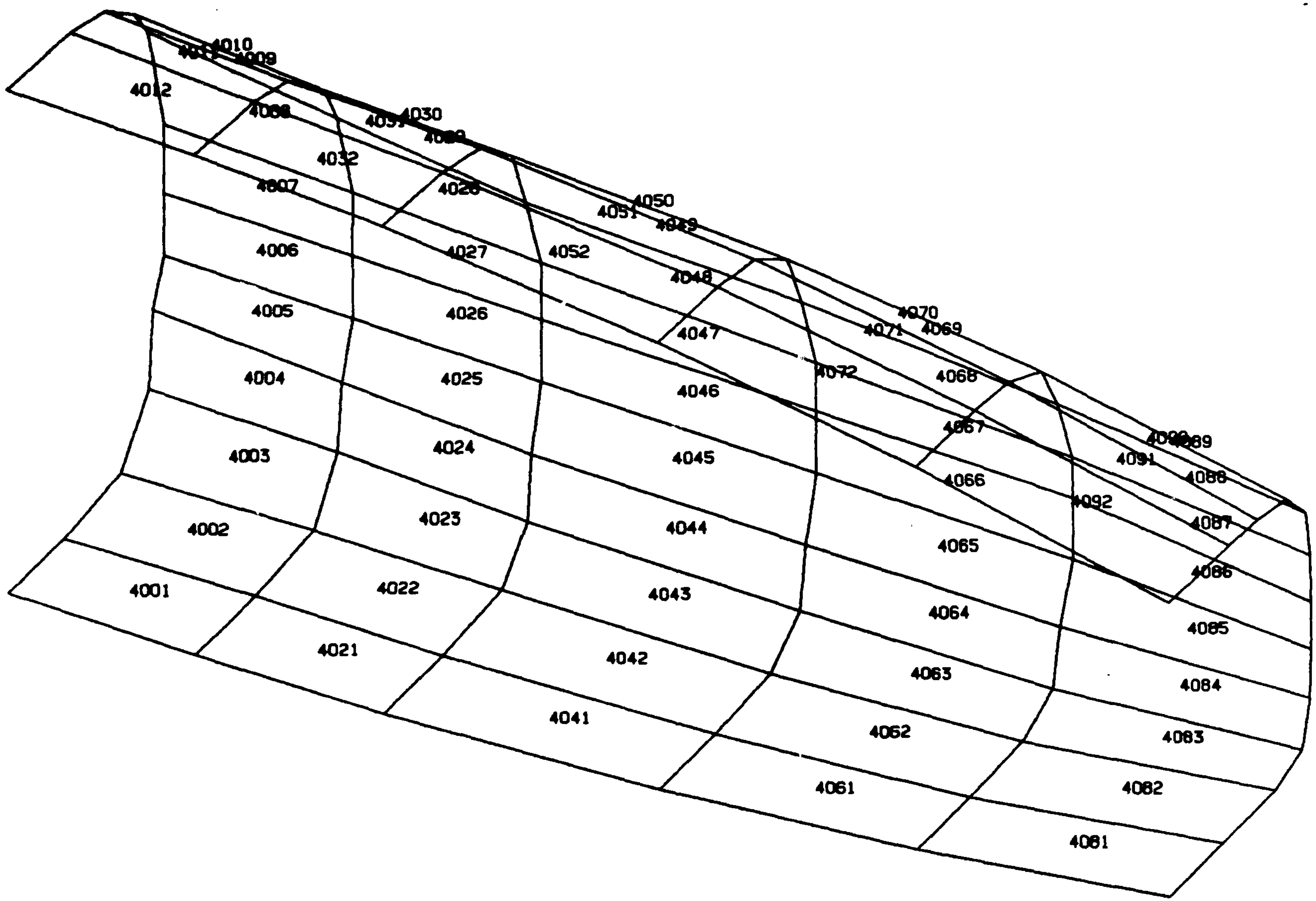
RALS DUCT TUNNEL ELEMENTS



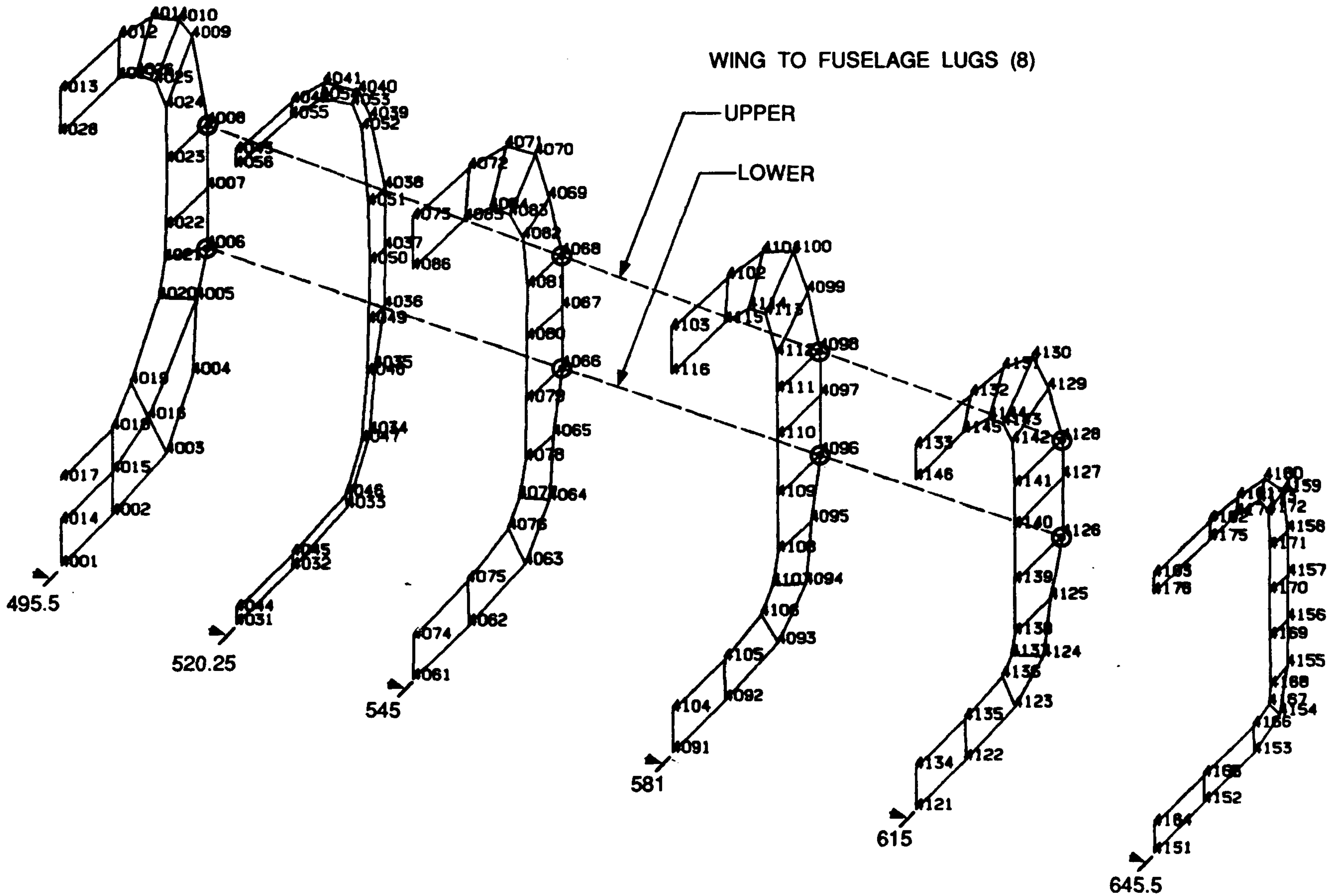
AFT FUSELAGE OML SKIN GRIDS



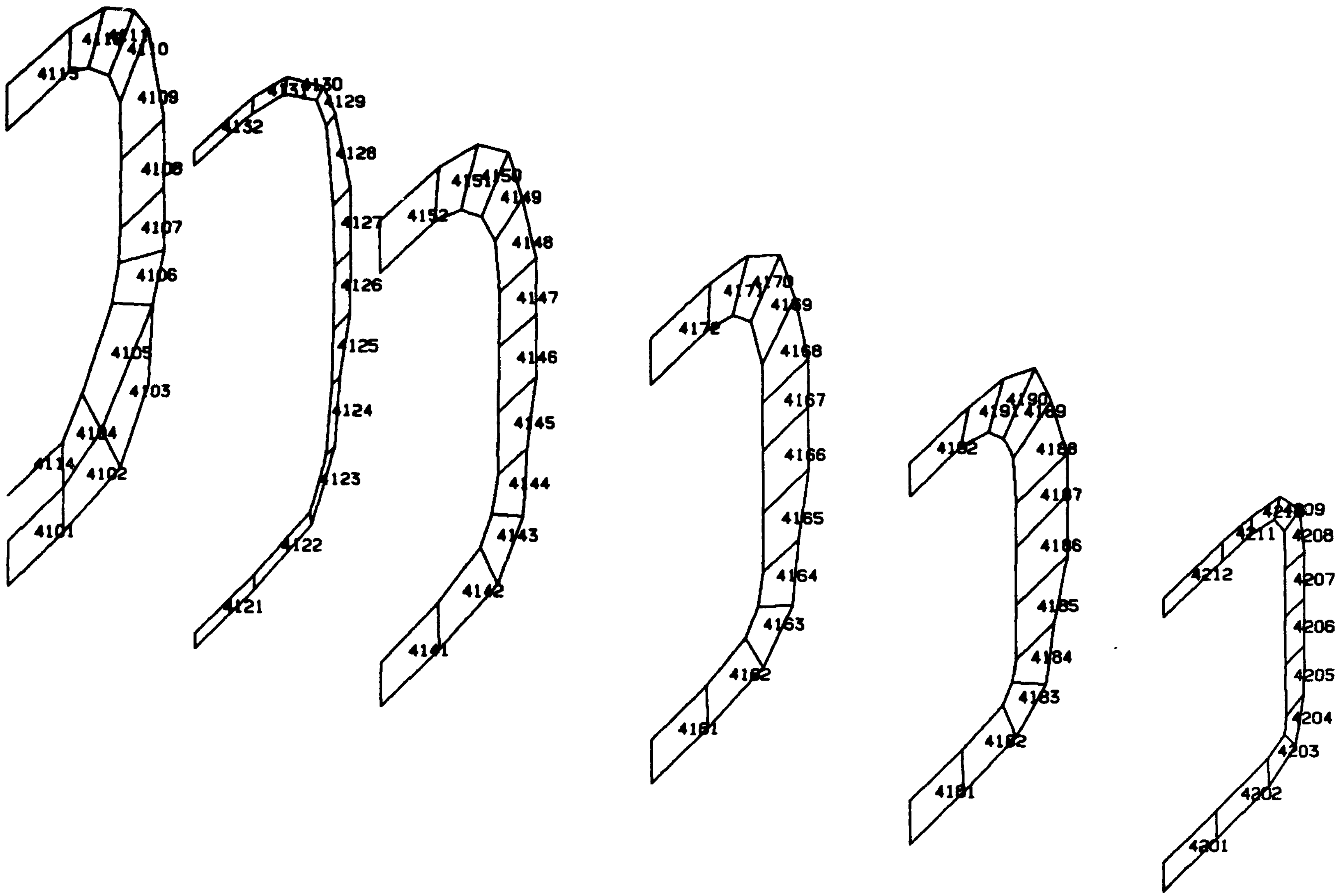
AFT FUSELAGE OML SKIN ELEMENTS



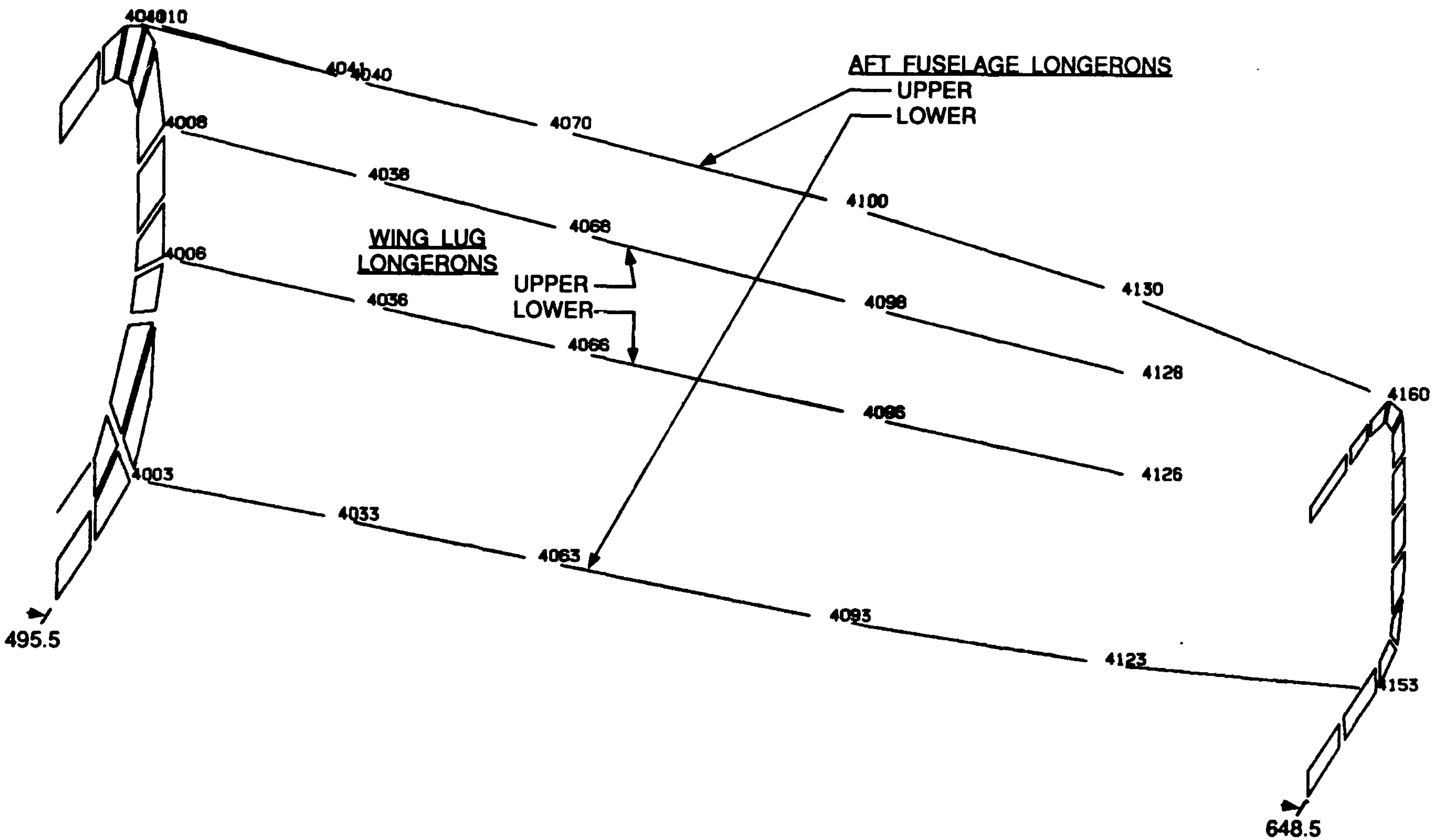
AFT FUSELAGE BULKHEAD AND FRAME GRIDS



AFT FUSELAGE BULKHEAD AND FRAME ELEMENTS



AFT FUSELAGE LONGERON GRIDS



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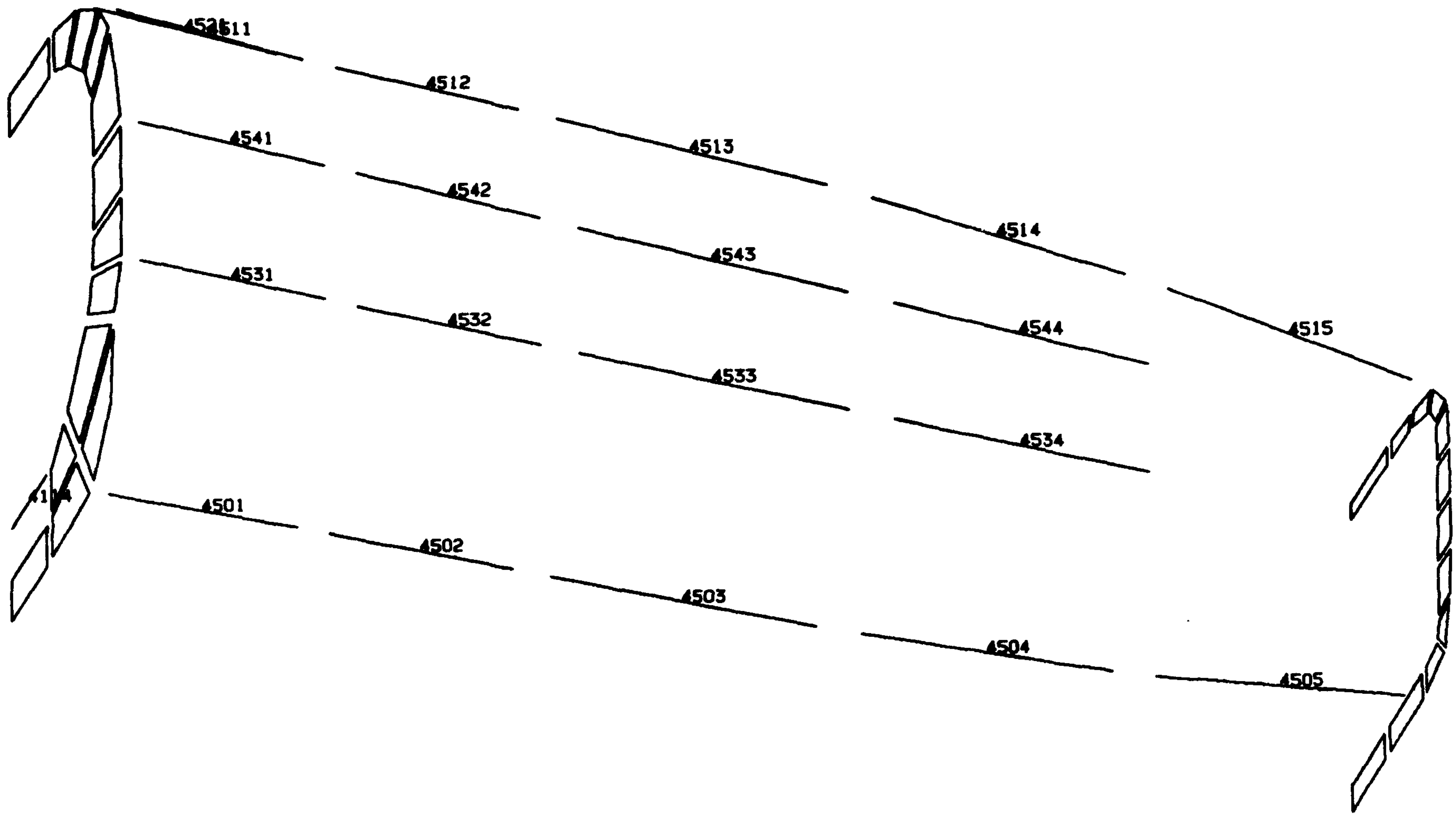
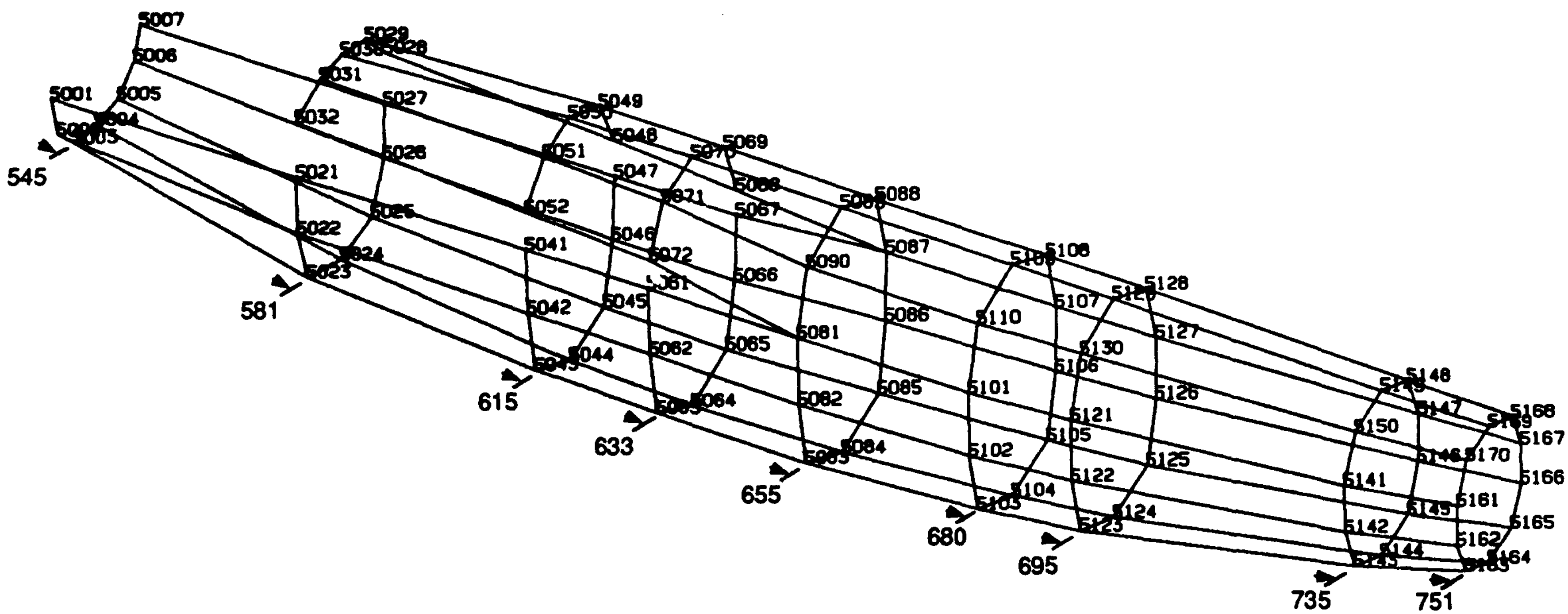
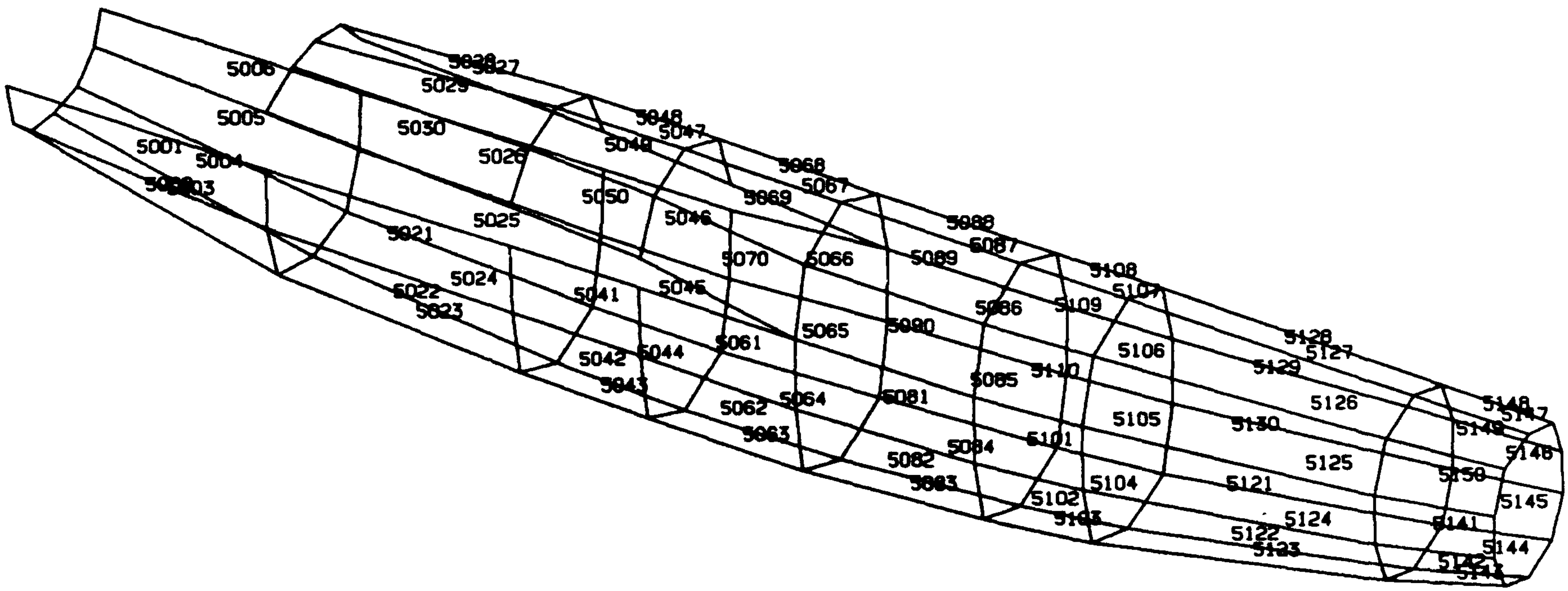


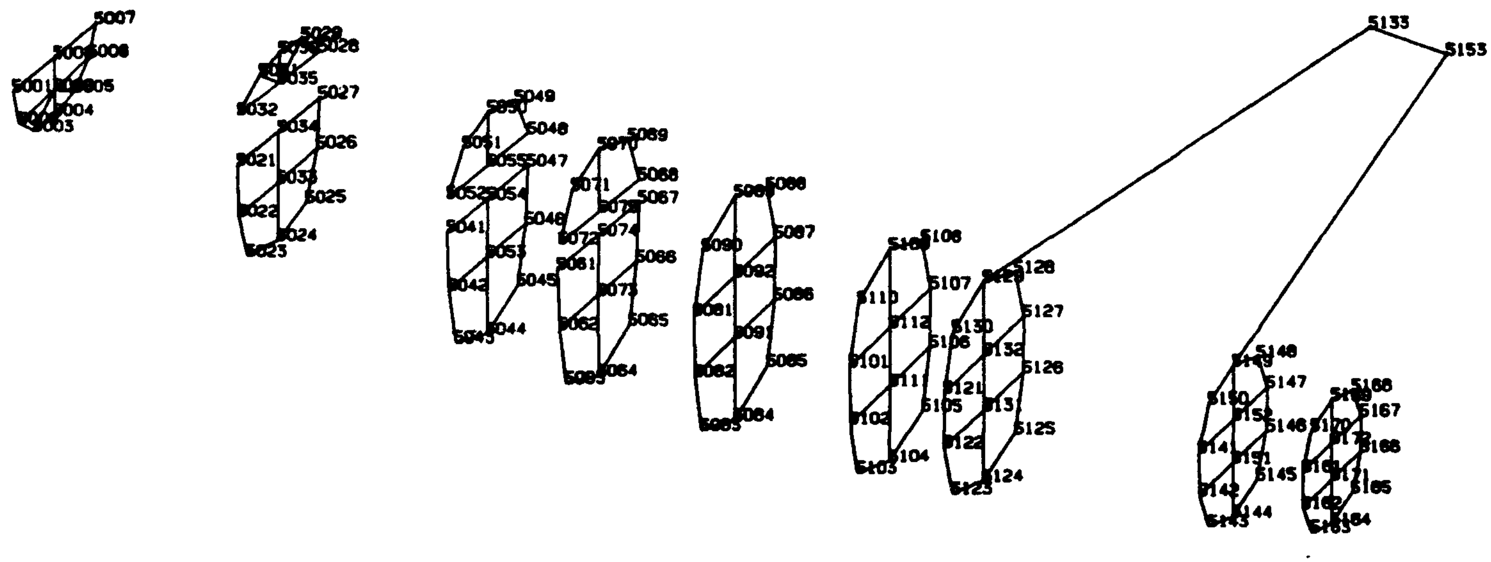
MLG/VERTICAL FIN POD OML SKIN GRIDS



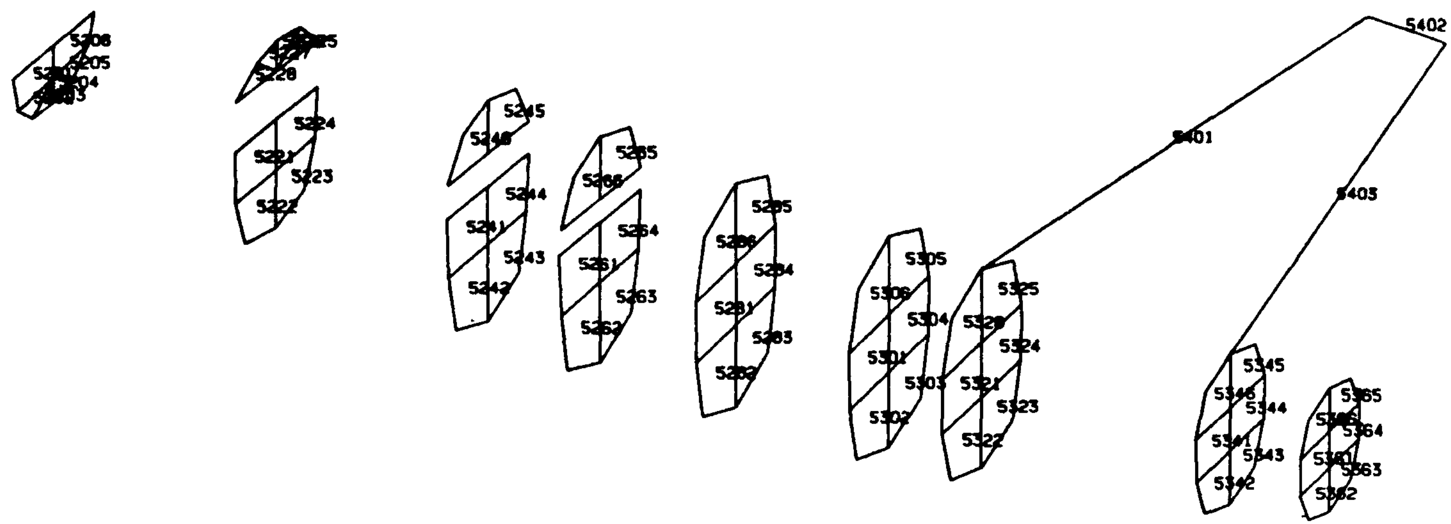
MLG/VERTICAL FIN POD OML SKIN ELEMENTS



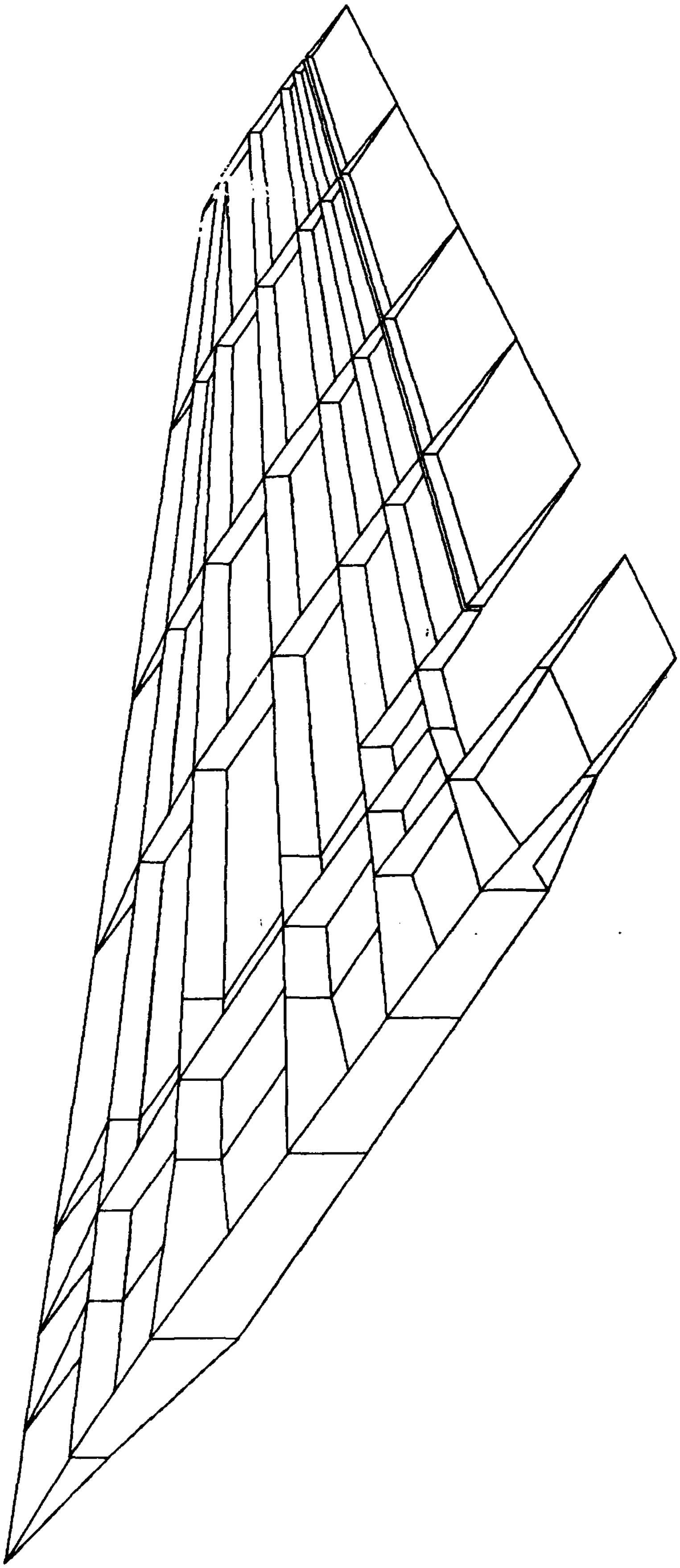
MLG/VERTICAL FIN POD BULKHEAD GRIDS



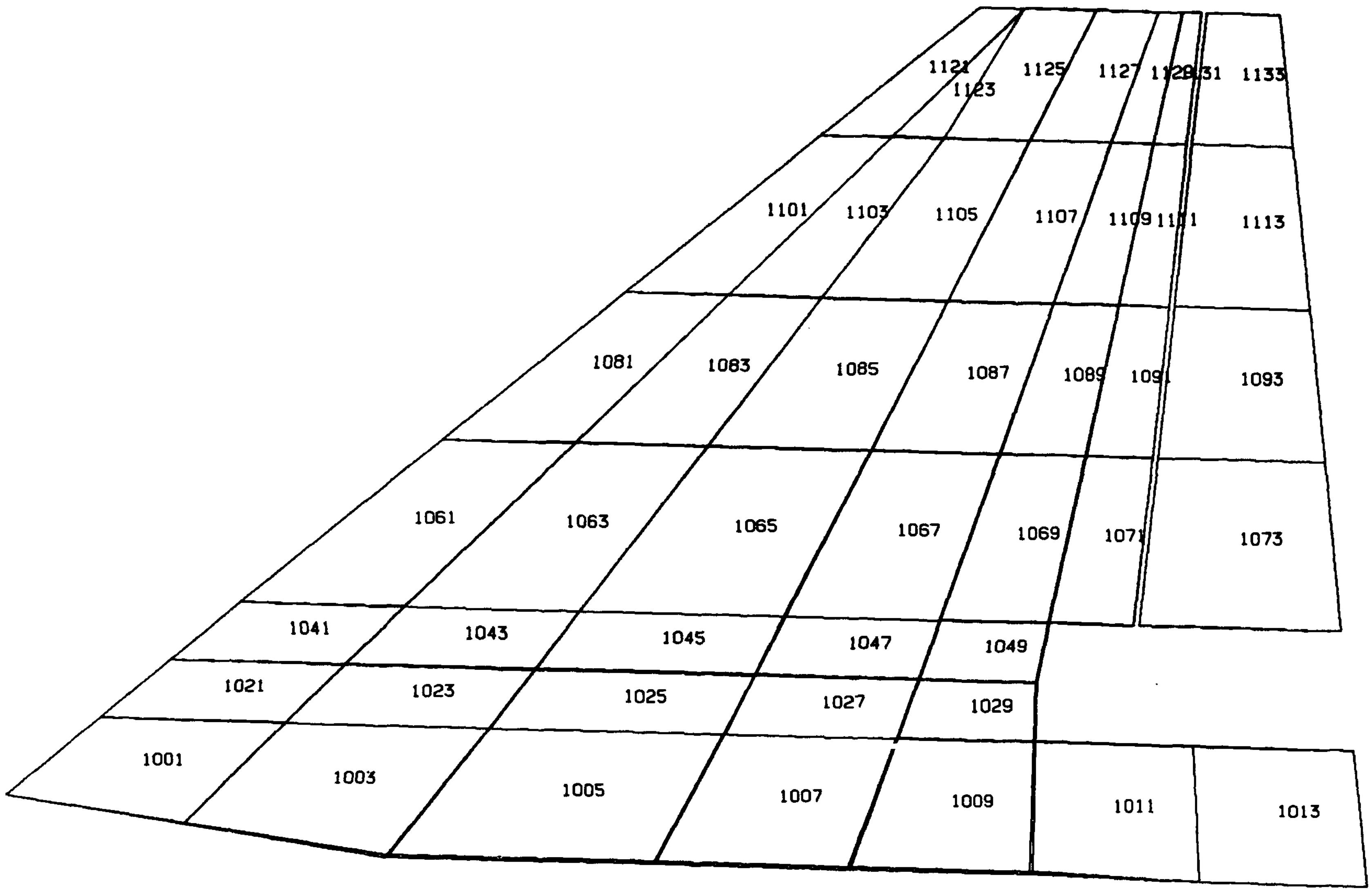
MLG/VERTICAL FIN POD BULKHEAD ELEMENTS



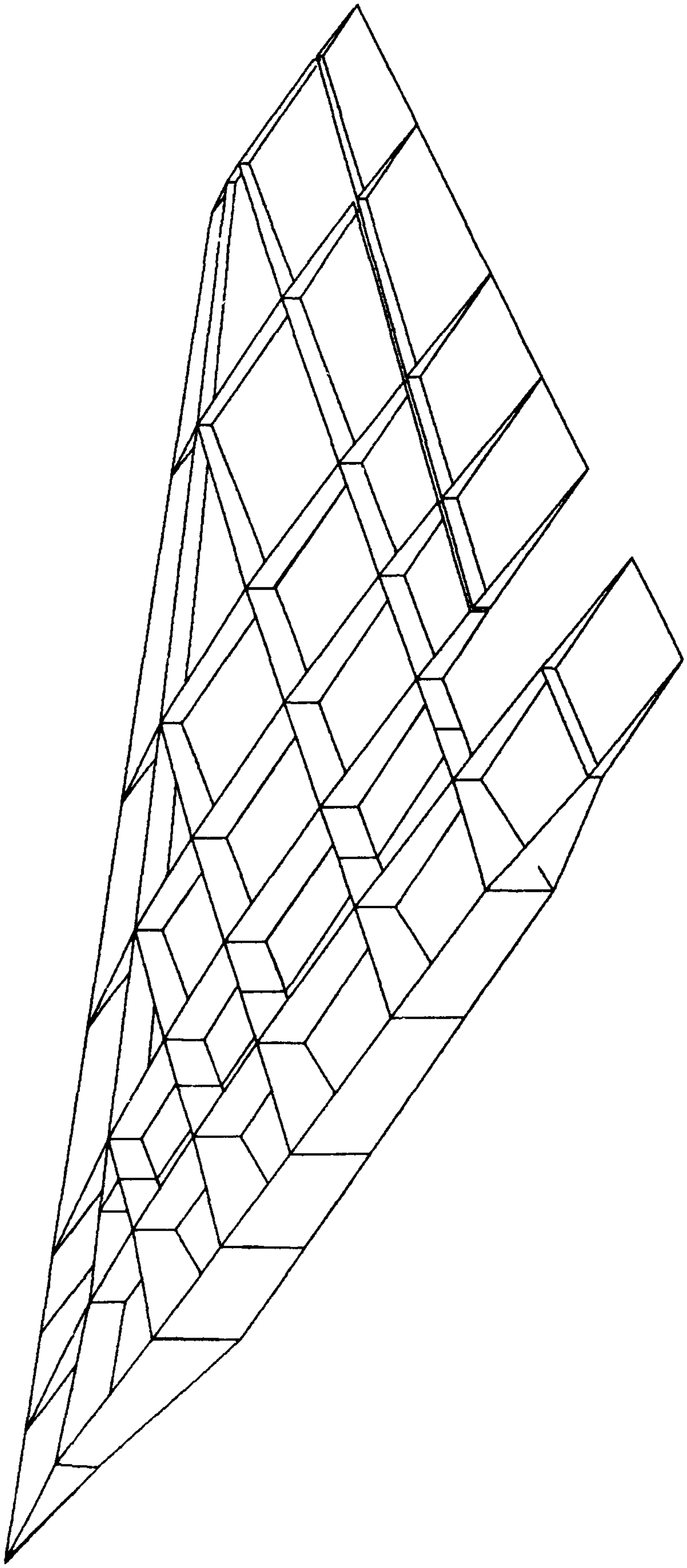
WING1 WITH UPPER SKIN REMOVED



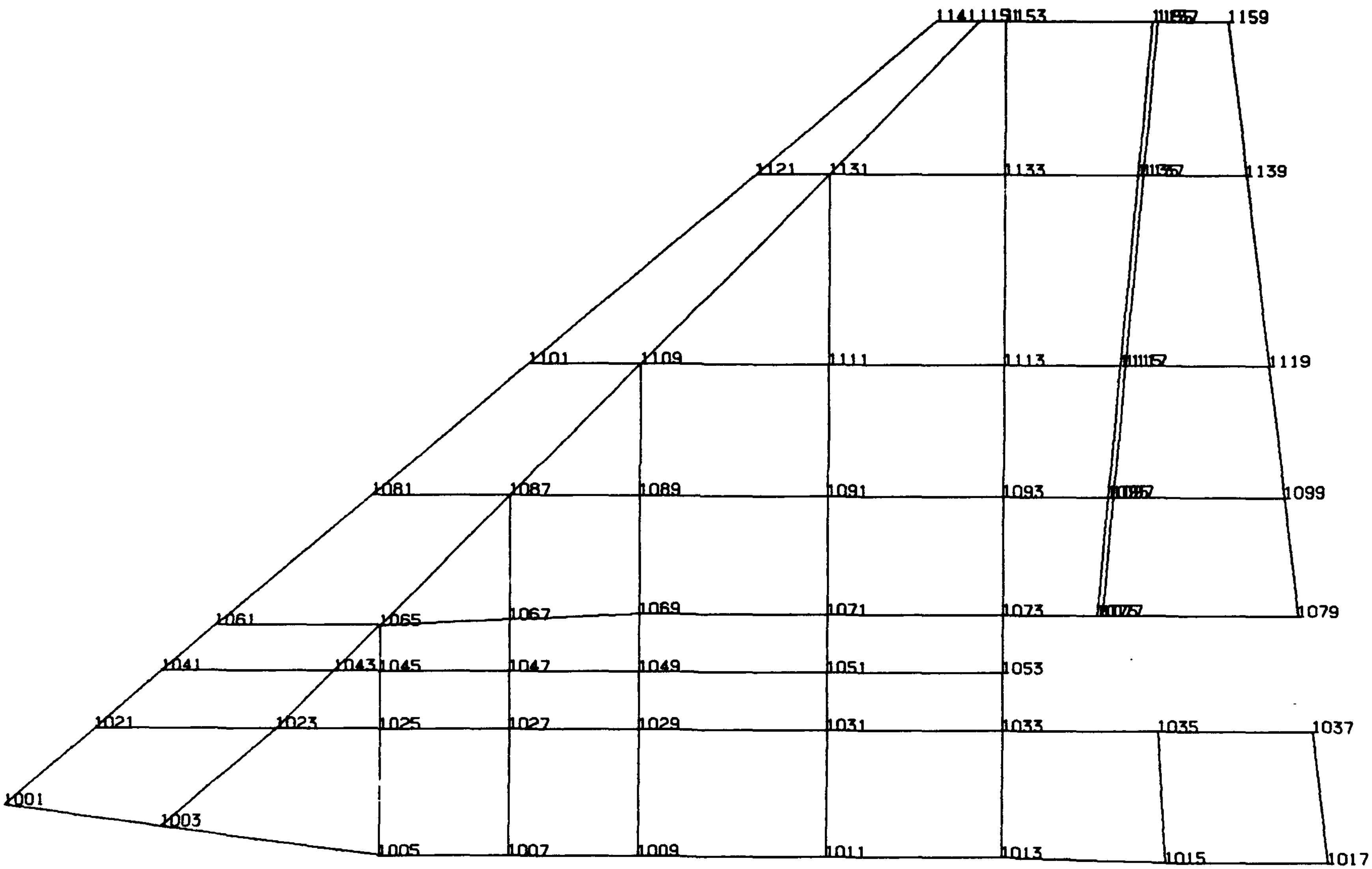
WING1 LOWER SKIN ELEMENTS



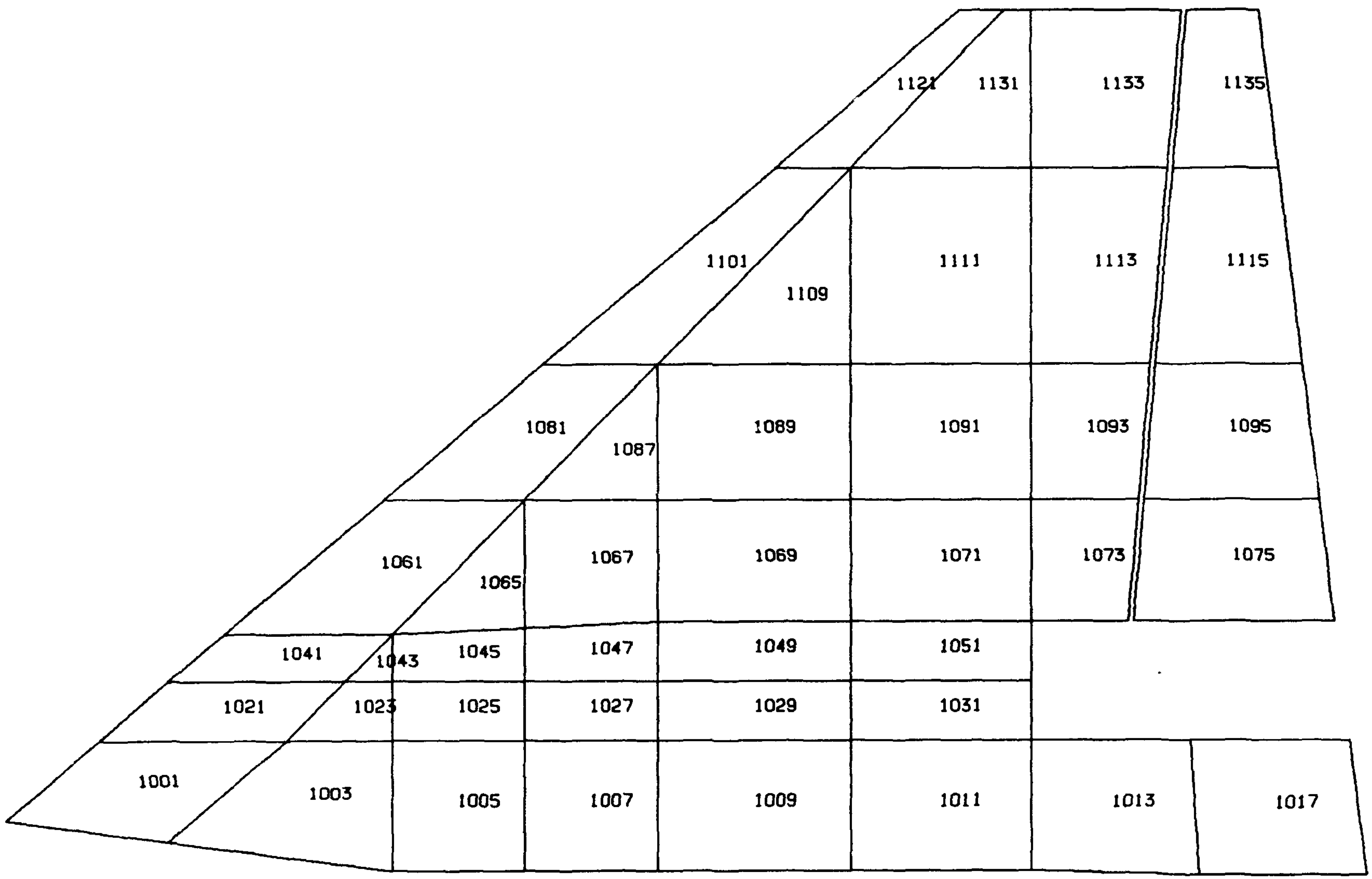
WING2 WITH UPPER SKIN REMOVED



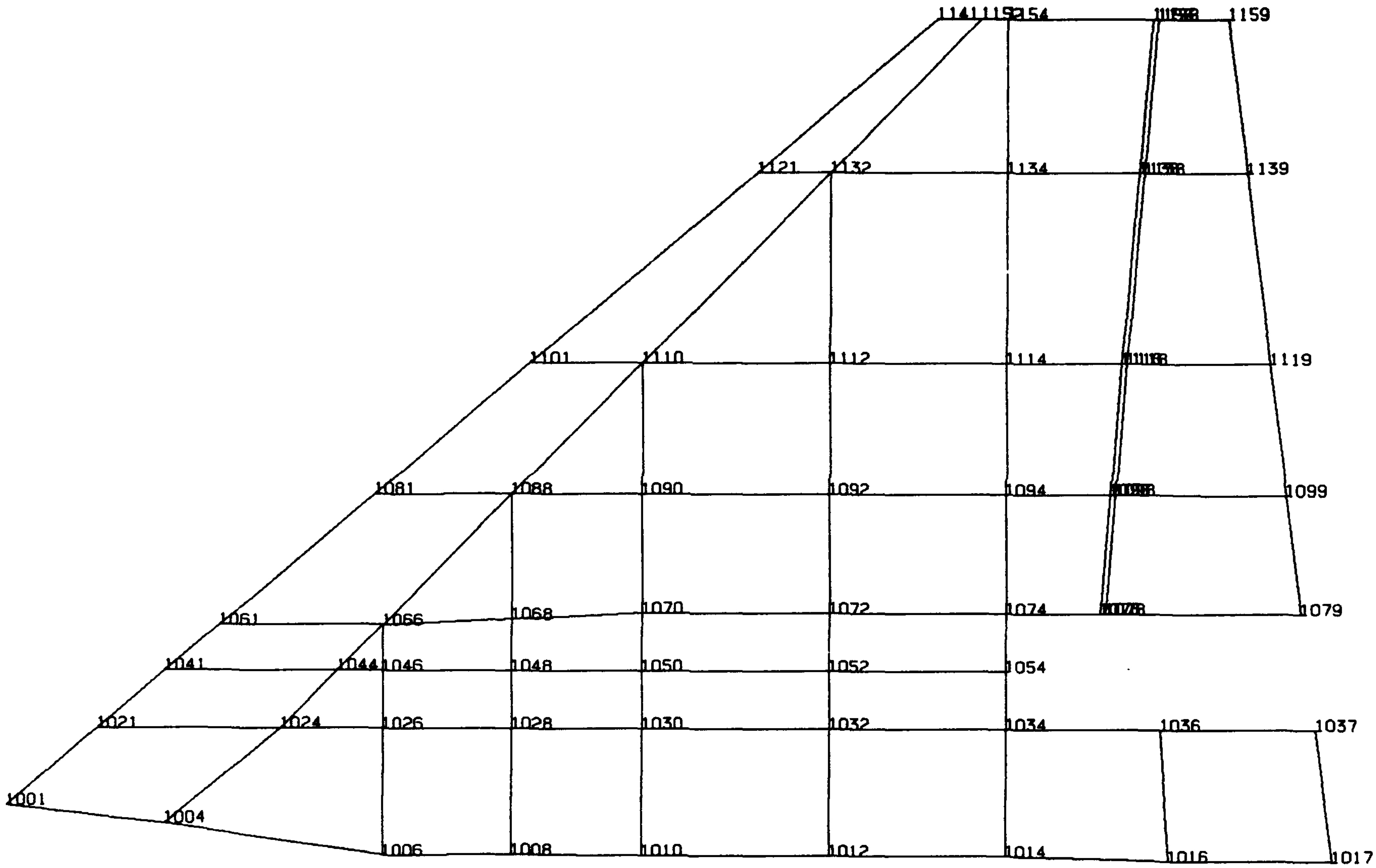
WING2 LOWER SKIN GRIDS



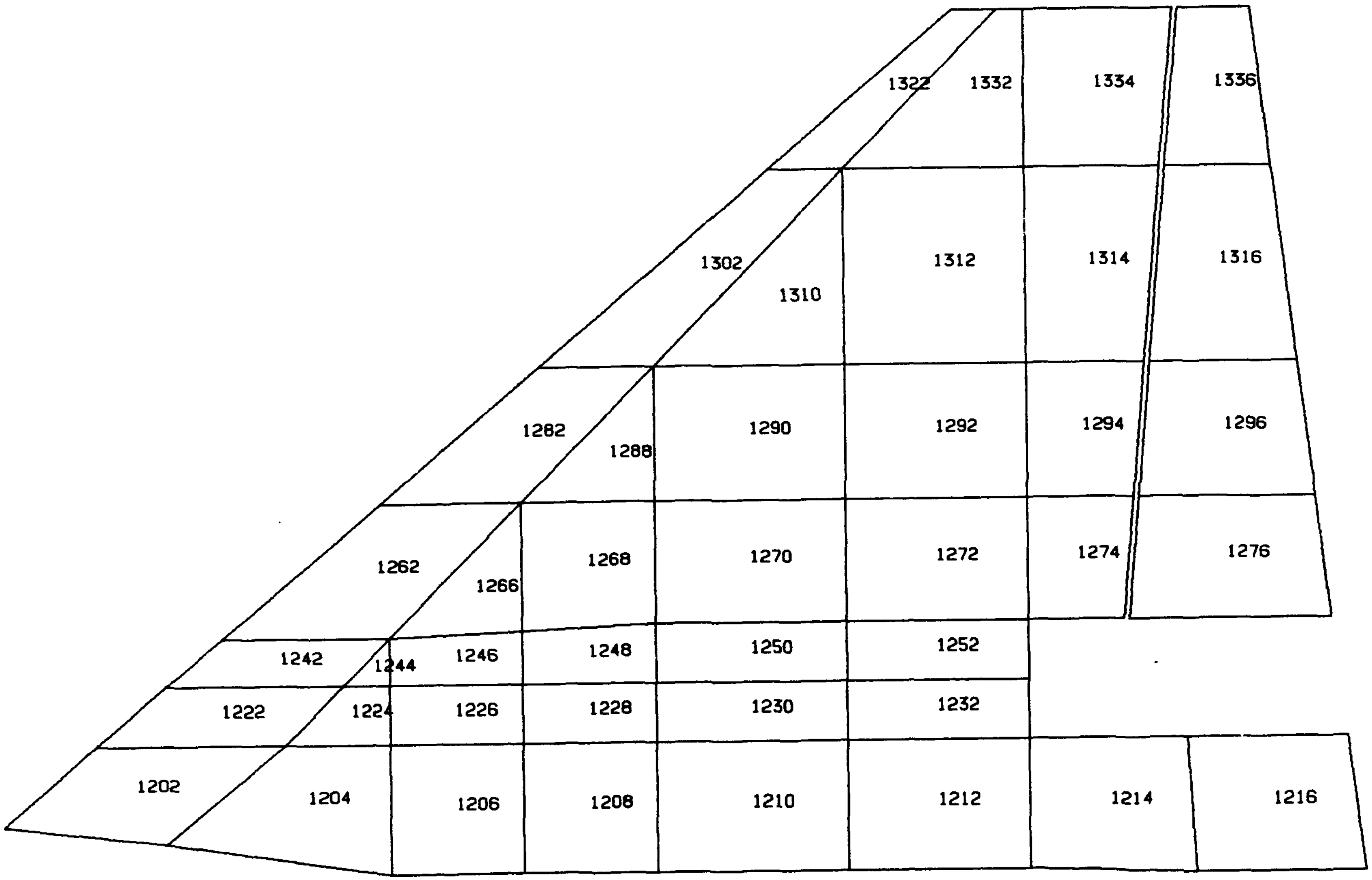
WING2 LOWER SKIN ELEMENTS



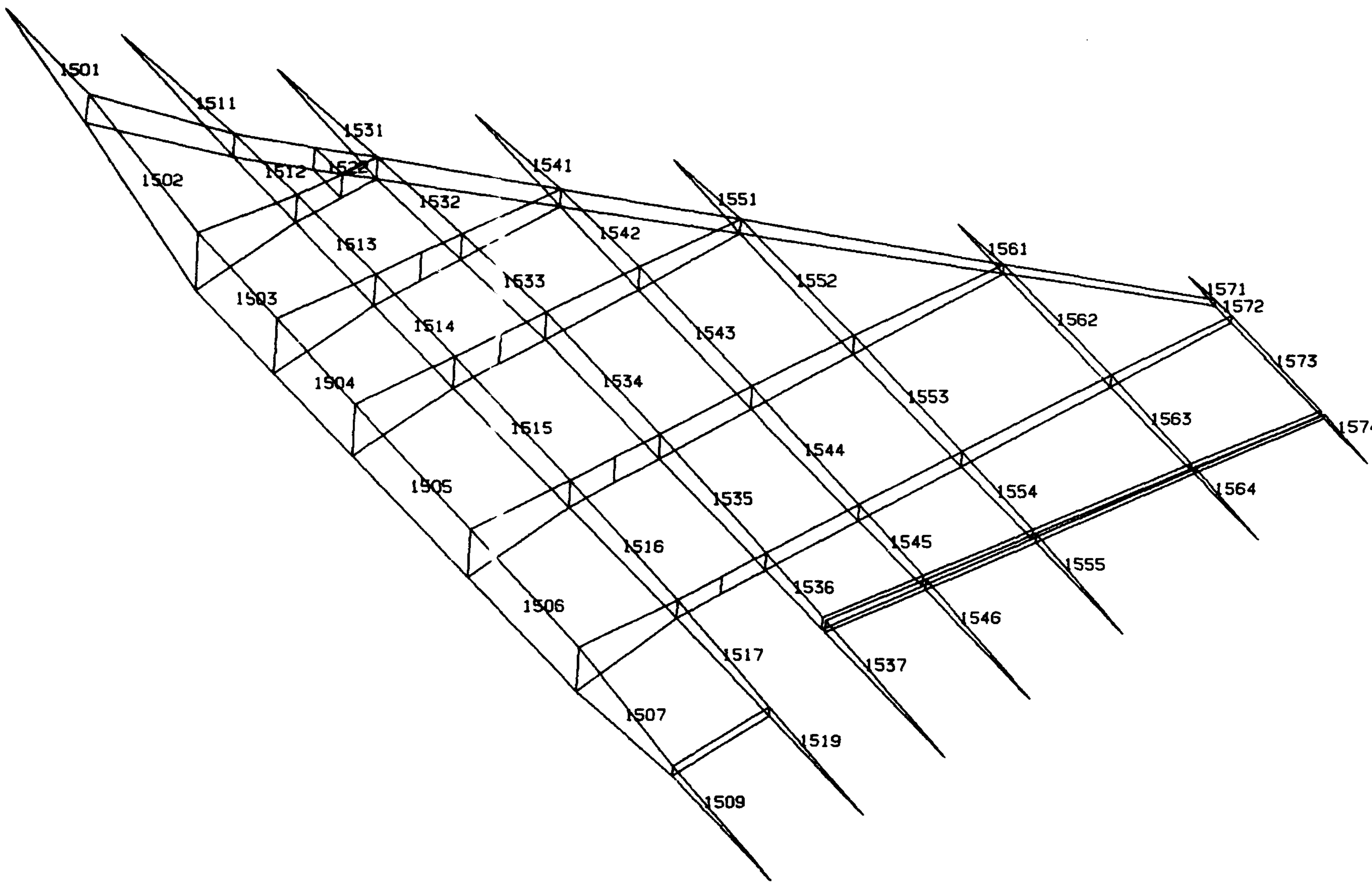
WING2 UPPER SKIN GRIDS



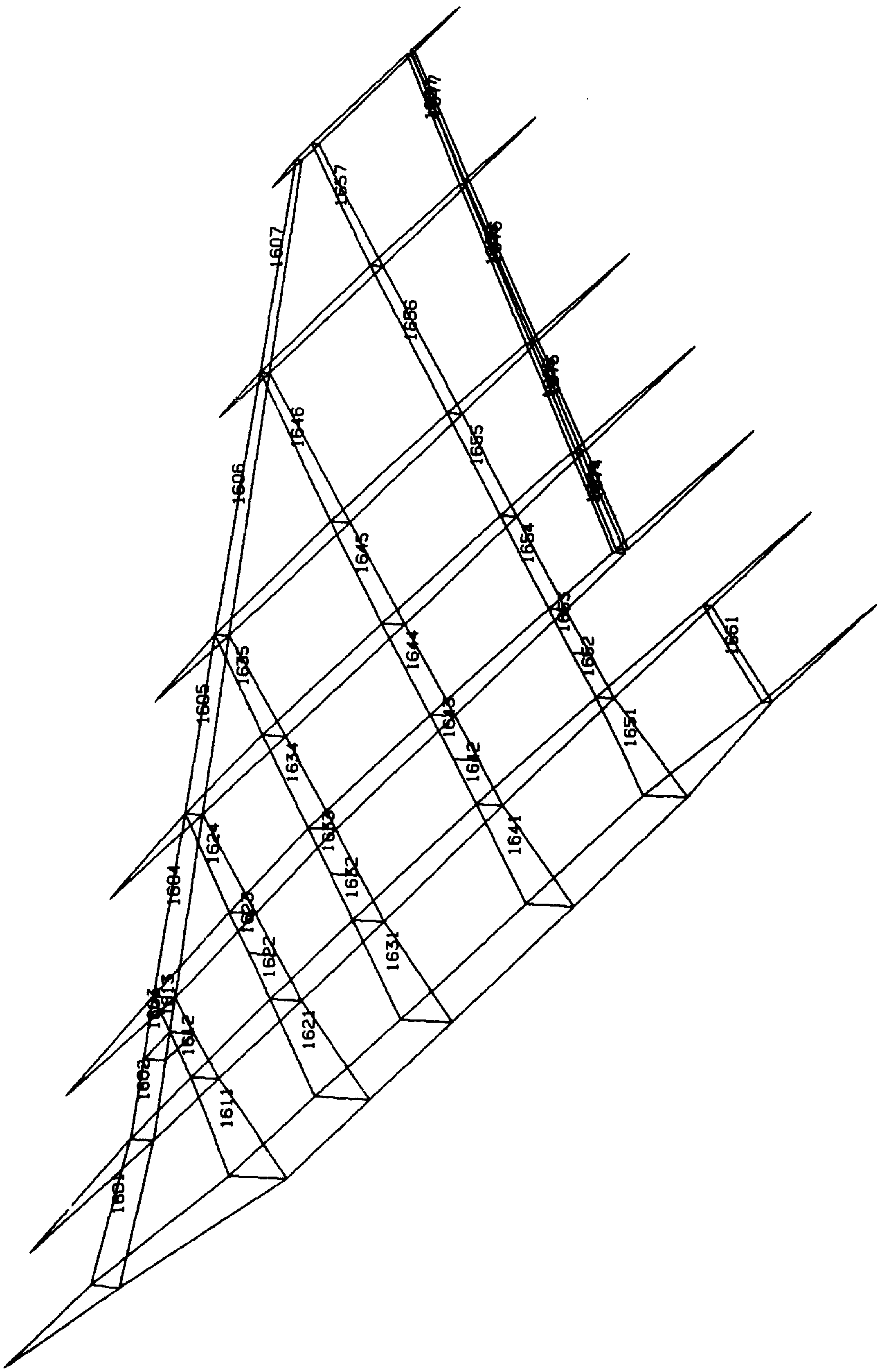
WING2 UPPER SKIN ELEMENTS



WING2 RIB ELEMENTS



WING2 SPAR ELEMENTS



A P P E N D I X   E

SUMMARY OF LOCAL DESIGN VARIABLE RESULTS

S U M M A R Y   O F   L O C A L   D E S I G N   V A R I A B L E S — I T E R A T I O N   5

A C T I V E   Q D M E M 1   &   T R M E M   E L E M E N T S

	EID	LAYER	LINKING OPTION	THICKNESS	T/TMIN	MINIMUM	MAXIMUM
WING LEADING EDGE	1001	1	SHAPE FUNCTION	2.89970748E-02	2.900E+00	1.000E-02	1.000E+04
INBOARD	1001	2	SHAPE FUNCTION	3.02337501E-02	3.023E+00	1.000E-02	1.000E+04
	1001	3	SHAPE FUNCTION	2.90128272E-02	2.901E+00	1.000E-02	1.000E+04
	1001	4	SHAPE FUNCTION	1.08251553E-02	1.083E+00	1.000E-02	1.000E+04
	1121	1	SHAPE FUNCTION	2.57077292E-02	2.571E+00	1.000E-02	1.000E+04
	1121	2	SHAPE FUNCTION	2.72987355E-02	2.730E+00	1.000E-02	1.000E+04
	1121	3	SHAPE FUNCTION	2.61155516E-02	2.612E+00	1.000E-02	1.000E+04
OUTBOARD	1121	4	SHAPE FUNCTION	1.24117611E-02	1.241E+00	1.000E-02	1.000E+04
LOWER WING SKIN							
FWD INBOARD	1003	1	SHAPE FUNCTION	3.02816201E-02	3.028E+00	1.000E-02	1.000E+04
	1003	2	SHAPE FUNCTION	2.87847184E-02	2.878E+00	1.000E-02	1.000E+04
	1003	3	SHAPE FUNCTION	1.00812204E-02	1.008E+00	1.000E-02	1.000E+04
	1003	4	SHAPE FUNCTION	1.00739144E-01	1.007E+01	1.000E-02	1.000E+04
	1009	1	SHAPE FUNCTION	2.72156205E-02	2.722E+00	1.000E-02	1.000E+04
	1009	2	SHAPE FUNCTION	3.24278399E-02	3.243E+00	1.000E-02	1.000E+04
	1009	3	SHAPE FUNCTION	1.35423681E-02	1.354E+00	1.000E-02	1.000E+04
	1009	4	SHAPE FUNCTION	8.44028071E-02	8.440E+00	1.000E-02	1.000E+04
AFT IBOARD	1013	1	SHAPE FUNCTION	2.66102981E-02	2.661E+00	1.000E-02	1.000E+04
	1013	2	SHAPE FUNCTION	3.44499722E-02	3.445E+00	1.000E-02	1.000E+04
	1013	3	SHAPE FUNCTION	1.56959426E-02	1.570E+00	1.000E-02	1.000E+04
	1013	4	SHAPE FUNCTION	7.57323951E-02	7.573E+00	1.000E-02	1.000E+04
	1069	1	SHAPE FUNCTION	2.93239262E-02	2.932E+00	1.000E-02	1.000E+04
	1069	2	SHAPE FUNCTION	2.82925218E-02	2.829E+00	1.000E-02	1.000E+04
	1069	3	SHAPE FUNCTION	1.72812399E-02	1.728E+00	1.000E-02	1.000E+04
	1069	4	SHAPE FUNCTION	7.83018693E-02	7.830E+00	1.000E-02	1.000E+04
	1087	1	SHAPE FUNCTION	3.14333178E-02	3.143E+00	1.000E-02	1.000E+04
	1087	2	SHAPE FUNCTION	2.24210452E-02	2.242E+00	1.000E-02	1.000E+04
	1087	3	SHAPE FUNCTION	1.49598559E-02	1.496E+00	1.000E-02	1.000E+04
	1087	4	SHAPE FUNCTION	8.69629681E-02	8.696E+00	1.000E-02	1.000E+04
	1093	1	SHAPE FUNCTION	2.75630672E-02	2.756E+00	1.000E-02	1.000E+04
	1093	2	SHAPE FUNCTION	2.82750204E-02	2.828E+00	1.000E-02	1.000E+04
	1093	3	SHAPE FUNCTION	2.07453668E-02	2.075E+00	1.000E-02	1.000E+04
	1093	4	SHAPE FUNCTION	6.10954352E-02	6.110E+00	1.000E-02	1.000E+04
	1109	1	SHAPE FUNCTION	2.83731669E-02	2.837E+00	1.000E-02	1.000E+04
	1109	2	SHAPE FUNCTION	1.84365623E-02	1.844E+00	1.000E-02	1.000E+04
	1109	3	SHAPE FUNCTION	1.44306235E-02	1.443E+00	1.000E-02	1.000E+04
	1109	4	SHAPE FUNCTION	7.71053359E-02	7.711E+00	1.000E-02	1.000E+04
FWD OUTBOARD	1131	1	SHAPE FUNCTION	2.23454032E-02	2.235E+00	1.000E-02	1.000E+04
	1131	2	SHAPE FUNCTION	1.33015122E-02	1.330E+00	1.000E-02	1.000E+04
	1131	3	SHAPE FUNCTION	1.21136243E-02	1.211E+00	1.000E-02	1.000E+04
	1131	4	SHAPE FUNCTION	6.27645105E-02	6.276E+00	1.000E-02	1.000E+04
AFT OUTBOARD	1133	1	SHAPE FUNCTION	2.00759023E-02	2.008E+00	1.000E-02	1.000E+04
	1133	2	SHAPE FUNCTION	1.67218074E-02	1.672E+00	1.000E-02	1.000E+04
	1133	3	SHAPE FUNCTION	1.54921738E-02	1.549E+00	1.000E-02	1.000E+04
	1133	4	SHAPE FUNCTION	4.76479344E-02	4.765E+00	1.000E-02	1.000E+04
AILERON	1075	1	SHAPE FUNCTION	5.99399731E-02	5.994E+00	1.000E-02	1.000E+04
INBOARD	1075	2	SHAPE FUNCTION	2.54514255E-02	2.545E+00	1.000E-02	1.000E+04
	1075	3	SHAPE FUNCTION	2.17562374E-02	2.176E+00	1.000E-02	1.000E+04
	1075	4	SHAPE FUNCTION	2.64778994E-02	2.648E+00	1.000E-02	1.000E+04
OUTBOARD	1135	1	SHAPE FUNCTION	5.80431446E-02	5.804E+00	1.000E-02	1.000E+04
	1135	2	SHAPE FUNCTION	2.40453724E-02	2.405E+00	1.000E-02	1.000E+04
	1135	3	SHAPE FUNCTION	2.10027713E-02	2.100E+00	1.000E-02	1.000E+04
	1135	4	SHAPE FUNCTION	2.46874746E-02	2.469E+00	1.000E-02	1.000E+04
UPPER WING SKIN							
FWD INBOARD	1204	1	SHAPE FUNCTION	3.18988040E-02	3.190E+00	1.000E-02	1.000E+04
	1204	2	SHAPE FUNCTION	5.74621074E-02	5.746E+00	1.000E-02	1.000E+04
	1204	3	SHAPE FUNCTION	1.02566732E-02	1.026E+00	1.000E-02	1.000E+04
	1204	4	SHAPE FUNCTION	1.04608662E-01	1.046E+01	1.000E-02	1.000E+04
	1210	1	SHAPE FUNCTION	4.13883142E-02	4.139E+00	1.000E-02	1.000E+04
	1210	2	SHAPE FUNCTION	5.86006679E-02	5.860E+00	1.000E-02	1.000E+04
	1210	3	SHAPE FUNCTION	1.53195160E-02	1.532E+00	1.000E-02	1.000E+04
	1210	4	SHAPE FUNCTION	9.54787210E-02	9.548E+00	1.000E-02	1.000E+04
AFT INBOARD	1214	1	SHAPE FUNCTION	4.68544848E-02	4.685E+00	1.000E-02	1.000E+04
	1214	2	SHAPE FUNCTION	5.97199090E-02	5.972E+00	1.000E-02	1.000E+04
	1214	3	SHAPE FUNCTION	1.83139592E-02	1.831E+00	1.000E-02	1.000E+04
	1214	4	SHAPE FUNCTION	9.02916640E-02	9.029E+00	1.000E-02	1.000E+04
	1270	1	SHAPE FUNCTION	3.57796662E-02	3.578E+00	1.000E-02	1.000E+04
	1270	2	SHAPE FUNCTION	5.23134582E-02	5.231E+00	1.000E-02	1.000E+04
	1270	3	SHAPE FUNCTION	2.64419969E-02	2.644E+00	1.000E-02	1.000E+04
	1270	4	SHAPE FUNCTION	8.41365829E-02	8.414E+00	1.000E-02	1.000E+04

S U M M A R Y O F L O C A L D E S I G N V A R I A B L E S — I T E R A T I O N 5

A C T I V E Q D M E M 1 & T R M E M E L E M E N T S

	EID	LAYER	LINKING OPTION	THICKNESS	T/TMIN	MINIMUM	MAXIMUM
	1288	1	SHAPE FUNCTION	2.45045722E-02	2.450E+00	1.000E-02	1.000E+04
	1288	2	SHAPE FUNCTION	4.74175736E-02	4.742E+00	1.000E-02	1.000E+04
	1288	3	SHAPE FUNCTION	2.60954760E-02	2.61[illegible]E+00	1.000E-02	1.000E+04
	1288	4	SHAPE FUNCTION	8.47576559E-02	8.476E+00	1.000E-02	1.000E+04
	1294	1	SHAPE FUNCTION	3.99445407E-02	3.994E+00	1.000E-02	1.000E+04
	1294	2	SHAPE FUNCTION	4.97165397E-02	4.972E+00	1.000E-02	1.000E+04
	1294	3	SHAPE FUNCTION	3.44082825E-02	3.441E+00	1.000E-02	1.000E+04
	1294	4	SHAPE FUNCTION	6.99720830E-02	6.997E+00	1.000E-02	1.000E+04
	1310	1	SHAPE FUNCTION	2.05080248E-02	2.051E+00	1.000E-02	1.000E+04
	1310	2	SHAPE FUNCTION	4.15240750E-02	4.152E+00	1.000E-02	1.000E+04
	1310	3	SHAPE FUNCTION	2.94012111E-02	2.940E+00	1.000E-02	1.000E+04
	1310	4	SHAPE FUNCTION	7.39749372E-02	7.397E+00	1.000E-02	1.000E+04
FWD OUTBOARD	1332	1	SHAPE FUNCTION	1.59089323E-02	1.591E+00	1.000E-02	1.000E+04
	1332	2	SHAPE FUNCTION	3.39544713E-02	3.395E+00	1.000E-02	1.000E+04
	1332	3	SHAPE FUNCTION	3.07488199E-02	3.075E+00	1.000E-02	1.000E+04
	1332	4	SHAPE FUNCTION	6.01092614E-02	6.011E+00	1.000E-02	1.000E+04
AFT OUTBOARD	1334	1	SHAPE FUNCTION	2.49285363E-02	2.493E+00	1.000E-02	1.000E+04
	1334	2	SHAPE FUNCTION	3.52940261E-02	3.529E+00	1.000E-02	1.000E+04
	1334	3	SHAPE FUNCTION	3.56043540E-02	3.560E+00	1.000E-02	1.000E+04
	1334	4	SHAPE FUNCTION	5.14714047E-02	5.147E+00	1.000E-02	1.000E+04

A C T I V E Q U A D 4 E L E M E N T S

	ELEMENT-ID	LAYER	LINKING OPTION	THICKNESS	T/TMIN	MINIMUM	MAXIMUM
RIBS 1 & 2	1502	1	SHAPE FUNCTION	7.45861679E-02	1.865E+00	4.000E-02	1.000E+04
RIBS 3 & 4	1532	1	SHAPE FUNCTION	7.39873946E-02	1.850E+00	4.000E-02	1.000E+04
RIBS 5 6 & 7	1552	1	SHAPE FUNCTION	7.03093112E-02	1.758E+00	4.000E-02	1.000E+04
LEADING EDGE SPAR	1601	1	SHAPE FUNCTION	6.88691884E-02	1.722E+00	4.000E-02	1.000E+04
	1607	1	SHAPE FUNCTION	6.97002932E-02	1.743E+00	4.000E-02	1.000E+04
INTERMEDIATE	1611	1	SHAPE FUNCTION	6.98277503E-02	1.746E+00	4.000E-02	1.000E+04
SPARS 1 & 2	1624	1	SHAPE FUNCTION	6.96658343E-02	1.742E+00	4.000E-02	1.000E+04
INTERMEDIATE	1631	1	SHAPE FUNCTION	6.14664555E-02	1.537E+00	4.000E-02	1.000E+04
SPAR 3	1635	1	SHAPE FUNCTION	6.41137287E-02	1.603E+00	4.000E-02	1.000E+04
INTERMEDIATE	1641	1	SHAPE FUNCTION	7.19065145E-02	1.798E+00	4.000E-02	1.000E+04
SPAR 4	1646	1	SHAPE FUNCTION	7.11065307E-02	1.77[illegible]E+00	4.000E-02	1.000E+04
INTERMEDIATE	1651	1	SHAPE FUNCTION	1.45168245E-01	3.[illegible]29E+00	4.000E-02	1.000E+04
SPAR 5	1657	1	SHAPE FUNCTION	1.11664914E-01	2.792E+00	4.000E-02	1.000E+04
INTERMEDIATE	1664	1	SHAPE FUNCTION	6.48106262E-02	1.620E+00	4.000E-02	1.000E+04
SPAR 6	1667	1	SHAPE FUNCTION	6.46348521E-02	1.616E+00	4.000E-02	1.000E+04
FWD FUSELAGE							
BOTTOM SKIN	2001	1	SHAPE FUNCTION	7.67434016E-02	1.919E+00	4.000E-02	1.000E+04
	2102	1	SHAPE FUNCTION	7.30452016E-02	1.826E+00	4.000E-02	1.000E+04
	2161	1	SHAPE FUNCTION	6.47592694E-02	1.619E+00	4.000E-02	1.000E+04
SIDE SKIN	2004	1	SHAPE FUNCTION	2.11828902E-01	5.296E+00	4.000E-02	1.000E+04
	2104	1	SHAPE FUNCTION	2.51223177E-01	6.281E+00	4.000E-02	1.000E+04
	2164	1	SHAPE FUNCTION	3.09698850E-01	7.742E+00	4.000E-02	1.000E+04
TOP SKIN	2010	1	SHAPE FUNCTION	1.20588139E-01	3.015E+00	4.000E-02	1.000E+04
FWD OF COCKPIT	2090	1	SHAPE FUNCTION	1.20724075E-01	3.018E+00	4.000E-02	1.000E+04
TOP SKIN	2171	1	SHAPE FUNCTION	9.84373614E-02	2.461E+00	4.000E-02	1.000E+04
AFT OF COCKPIT	2174	1	SHAPE FUNCTION	9.83484909E-02	2.459E+00	4.000E-02	1.000E+04
BHD 175	2201	1	SHAPE FUNCTION	1.00347213E-01	2.509E+00	4.000E-02	1.000E+04
BHD 195	2221	1	SHAPE FUNCTION	1.00017168E-01	2.500E+00	4.000E-02	1.000E+04
BHD 228	2232	1	SHAPE FUNCTION	1.00075342E-01	2.502E+00	4.000E-02	1.000E+04
BHD 269	2261	1	SHAPE FUNCTION	1.29964203E-01	3.249E+00	4.000E-02	1.000E+04
BHD 282	2271	1	SHAPE FUNCTION	1.00725397E-01	2.518E+00	4.000E-02	1.000E+04
COCPIT FLOOR	2301	1	SHAPE FUNCTION	1.01593100E-01	2.540E+00	4.000E-02	1.000E+04
	2311	1	SHAPE FUNCTION	1.28568038E-01	3.214E+00	4.000E-02	1.000E+04
	2317	1	SHAPE FUNCTION	1.58147722E-01	3.954E+00	4.000E-02	1.000E+04
CENTER FUSELAGE							
BOTTOM SKIN	3001	1	SHAPE FUNCTION	1.08814351E-01	2.720E+00	4.000E-02	1.000E+04
	3041	1	SHAPE FUNCTION	1.18270814E-01	2.957E+00	4.000E-02	1.000E+04
	3101	1	SHAPE FUNCTION	1.39609411E-01	3.490E+00	4.000E-02	1.000E+04

S U M M A R Y   O F   L O C A L   D E S I G N   V A R I A B L E S — I T E R A T I O N 5

A C T I V E   Q U A D 4 & T R I A 3   E L E M E N T S

	EID	LAYER	LINKING OPTION	THICKNESS	T/TMIN	MINIMUM	MAXIMUM
SIDE SKIN	3005	1	SHAPE FUNCTION	1.14072822E-01	2.852E+00	4.000E-02	1.000E+04
	3045	1	SHAPE FUNCTION	1.17169149E-01	2.929E+00	4.000E-02	1.000E+04
	3105	1	SHAPE FUNCTION	1.25590980E-01	3.140E+00	4.000E-02	1.000E+04
TOP SKIN	3008	1	SHAPE FUNCTION	1.09470971E-01	2.737E+00	4.000E-02	1.000E+04
	3053	1	SHAPE FUNCTION	1.19128324E-01	2.978E+00	4.000E-02	1.000E+04
	3112	1	SHAPE FUNCTION	1.40676320E-01	3.517E+00	4.000E-02	1.000E+04
BHD 330	3121	1	SHAPE FUNCTION	1.00424327E-01	2.511E+00	4.000E-02	1.000E+04
BHD 360	3141	1	SHAPE FUNCTION	1.02676034E-01	2.567E+00	4.000E-02	1.000E+04
BHD 390	3161	1	SHAPE FUNCTION	1.54217646E-01	3.855E+00	4.000E-02	1.000E+04
BHD 420	3191	1	SHAPE FUNCTION	1.07069001E-01	2.677E+00	4.000E-02	1.000E+04
BHD 454	3221	1	SHAPE FUNCTION	9.98710543E-02	2.497E+00	4.000E-02	1.000E+04
BHD 475	3251	1	SHAPE FUNCTION	1.45064816E-01	3.627E+00	4.000E-02	1.000E+04
FUEL TANK FLOOR	3271	1	SHAPE FUNCTION	9.72153917E-02	2.430E+00	4.000E-02	1.000E+04
	3281	1	SHAPE FUNCTION	1.17692359E-01	2.942E+00	4.000E-02	1.000E+04
ENGINE INLET OML SKIN	3304	1	SHAPE FUNCTION	9.84626710E-02	2.462E+00	4.000E-02	1.000E+04
	3352	1	SHAPE FUNCTION	1.33438110E-01	3.336E+00	4.000E-02	1.000E+04
INLET FRAMES							
1	3361	1	SHAPE FUNCTION	1.03164904E-01	2.579E+00	4.000E-02	1.000E+04
2	3381	1	SHAPE FUNCTION	1.78517848E-01	4.463E+00	4.000E-02	1.000E+04
3	3401	1	SHAPE FUNCTION	3.00445348E-01	7.511E+00	4.000E-02	1.000E+04
RALS DUCT TUNNEL	3801	1	SHAPE FUNCTION	5.60697801E-02	1.402E+00	4.000E-02	1.000E+04
	3831	1	SHAPE FUNCTION	6.03776425E-02	1.509E+00	4.000E-02	1.000E+04
INLET IML SKIN	3902	1	SHAPE FUNCTION	4.98026945E-02	1.245E+00	4.000E-02	1.000E+04
	3981	1	SHAPE FUNCTION	8.01287889E-02	2.003E+00	4.000E-02	1.000E+04
AFT FUSELAGE							
BOTTOM SKIN	4001	1	SHAPE FUNCTION	8.34149271E-02	2.085E+00	4.000E-02	1.000E+04
	4041	1	SHAPE FUNCTION	9.22776312E-02	2.307E+00	4.000E-02	1.000E+04
	4081	1	SHAPE FUNCTION	1.07954949E-01	2.699E+00	4.000E-02	1.000E+04
SIDE SKIN	4004	1	SHAPE FUNCTION	8.30065459E-02	2.075E+00	4.000E-02	1.000E+04
	4044	1	SHAPE FUNCTION	9.14109722E-02	2.285E+00	4.000E-02	1.000E+04
	4084	1	SHAPE FUNCTION	1.06483877E-01	2.662E+00	4.000E-02	1.000E+04
TOP SKIN	4010	1	SHAPE FUNCTION	9.74599123E-02	2.436E+00	4.000E-02	1.000E+04
	4050	1	SHAPE FUNCTION	9.88721699E-02	2.472E+00	4.000E-02	1.000E+04
	4090	1	SHAPE FUNCTION	1.04077317E-01	2.602E+00	4.000E-02	1.000E+04
BHD 495	4101	1	SHAPE FUNCTION	3.69270295E-01	9.232E+00	4.000E-02	1.000E+04
	4107	1	SHAPE FUNCTION	3.70166600E-01	9.254E+00	4.000E-02	1.000E+04
	4113	1	SHAPE FUNCTION	3.71722668E-01	9.293E+00	4.000E-02	1.000E+04
FRAME 520	4121	1	SHAPE FUNCTION	2.44615778E-01	6.115E+00	4.000E-02	1.000E+04
BHD 545	4141	1	SHAPE FUNCTION	4.43633884E-01	1.109E+01	4.000E-02	1.000E+04
	4146	1	SHAPE FUNCTION	4.44488078E-01	1.111E+01	4.000E-02	1.000E+04
	4152	1	SHAPE FUNCTION	4.46148127E-01	1.115E+01	4.000E-02	1.000E+04
BHD 581	4181	1	SHAPE FUNCTION	3.03169489E-01	7.579E+00	4.000E-02	1.000E+04
	4186	1	SHAPE FUNCTION	3.02887261E-01	7.572E+00	4.000E-02	1.000E+04
	4192	1	SHAPE FUNCTION	3.02400887E-01	7.560E+00	4.000E-02	1.000E+04
FRAME 648.5	4201	1	SHAPE FUNCTION	1.12922318E-01	2.823E+00	4.000E-02	1.000E+04
MLG/VERTICAL FIN POD							
OML SKINS	5001	1	SHAPE FUNCTION	1.47071481E-01	3.677E+00	4.000E-02	1.000E+04
	5061	1	SHAPE FUNCTION	1.43629149E-01	3.591E+00	4.000E-02	1.000E+04
	5063	1	SHAPE FUNCTION	1.43629149E-01	3.591E+00	4.000E-02	1.000E+04
	5069	1	SHAPE FUNCTION	1.43629149E-01	3.591E+00	4.000E-02	1.000E+04
	5141	1	SHAPE FUNCTION	1.39421850E-01	3.486E+00	4.000E-02	1.000E+04
BHDS 545 581	5201	1	SHAPE FUNCTION	1.00724898E-01	2.518E+00	4.000E-02	1.000E+04
BHDS 615 633	5241	1	SHAPE FUNCTION	1.54409364E-01	3.860E+00	4.000E-02	1.000E+04
BHDS 655 680 695	5281	1	SHAPE FUNCTION	6.92035407E-02	1.730E+00	4.000E-02	1.000E+04
BHDS 735 751	5341	1	SHAPE FUNCTION	8.90274793E-02	2.226E+00	4.000E-02	1.000E+04

SUMMARY OF LOCAL DESIGN VARIABLES — ITERATION 5

ACTIVE ROD ELEMENTS

	EID	LINKING OPTION	AREA	MINIMUM	MAXIMUM
LONGERONS AND STIFFENERS					
FWD FUSELAGE LONGERONS					
LOWER	2501	SHAPE FUNCTION	1.64299205E-01	1.200E-01	1.000E+04
	2511	SHAPE FUNCTION	1.62921518E-01	1.200E-01	1.000E+04
UPPER	2521	SHAPE FUNCTION	4.71130490E-01	1.200E-01	1.000E+04
	2531	SHAPE FUNCTION	5.64775348E-01	1.200E-01	1.000E+04
CENTER FUSELAGE LONGERONS					
LOWER	3501	SHAPE FUNCTION	1.79392830E-01	1.200E-01	1.000E+04
	3506	SHAPE FUNCTION	1.81376308E-01	1.200E-01	1.000E+04
UPPER	3511	SHAPE FUNCTION	1.94491833E-01	1.200E-01	1.000E+04
	3516	SHAPE FUNCTION	1.95437089E-01	1.200E-01	1.000E+04
DORSAL	3521	SHAPE FUNCTION	1.54374838E-01	1.200E-01	1.000E+04
	3526	SHAPE FUNCTION	1.55407414E-01	1.200E-01	1.000E+04
INLET LOWER	3551	SHAPE FUNCTION	1.51839986E-01	1.200E-01	1.000E+04
	3557	SHAPE FUNCTION	1.52759105E-01	1.200E-01	1.000E+04
INLET UPPER	3561	SHAPE FUNCTION	1.51585266E-01	1.200E-01	1.000E+04
	3567	SHAPE FUNCTION	1.51996478E-01	1.200E-01	1.000E+04
AFT FUSELAGE					
LOWER LONGERON	4501	SHAPE FUNCTION	1.55754492E-01	1.200E-01	1.000E+04
	4505	SHAPE FUNCTION	1.56366199E-01	1.200E-01	1.000E+04
UPPER LONGERON	4511	SHAPE FUNCTION	1.54315248E-01	1.200E-01	1.000E+04
	4515	SHAPE FUNCTION	1.54939950E-01	1.200E-01	1.000E+04
LOWER WING LUG STIFFENER	4531	SHAPE FUNCTION	1.48471281E-01	1.200E-01	1.000E+04
	4534	SHAPE FUNCTION	1.48246557E-01	1.200E-01	1.000E+04
UPPER WING LUG STIFFENER	4541	SHAPE FUNCTION	1.50670201E-01	1.200E-01	1.000E+04
	4544	SHAPE FUNCTION	1.50842860E-01	1.200E-01	1.000E+04
MLG/VERTICAL FIN POD STIFFENERS					
TOP/BOTTOM	5502	SHAPE FUNCTION	1.59251675E-01	1.200E-01	1.000E+04
SIDE	5522	SHAPE FUNCTION	1.47056922E-01	1.200E-01	1.000E+04